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- UAVs Take Flight at the U.S. Naval Academy
 A Telemaster becomes a missioncompliant drone

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ON THE COVER: With tons of scale detail, this 63-inch-span warbird comes with a powerful motor and radio system installed. Don't miss our exclusive review on page 20. (Photo by Lesley Cunningham Greenlee)

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Now that fixed-wing and multirotor drones are being used literally everywhere for aerial surveys and photography, have you ever thought about making some cash in your spare time after taking the FAA's Part 107 exam and getting your small unmanned aircraft pilot certification? If so, you don't want to miss our feature "Making the Grade," which tells you what you need to study to pass this test with flying colors. Getting certified is easier than you may think!

Who doesn't remember the famous Lazy Bee line of airplanes? With tab-and-slot construction, even a total novice builder like me could put a Lazy Bee kit together. (My Lazy Bee looked terrific—at least until I inexpertly covered the wing—and it flew well!). This month, we have a special treat for you builders: Lazy Bee designer Andy Clancy is back with another rendition of his famous aircraft: the twin-motor Bee Liner (plans are available at AirAgeStore.com). If you're more into scratch building, you'll appreciate our informative feature on using CAD programs to create your own plans.

If you have a hangar full of various brands of electric aircraft, then you know what a hassle it can be to find the right connectors for your batteries, chargers, and more. This month's Ultimate Electrics column details the various types of electric connectors and the pros and cons of each. And if you'd like to change some of your connectors, we share the easy way to create sound joints in "How to Solder Deans Ultra Connectors." And if you're looking to upgrade your transmitter, we showcase six new programmable radio systems that may even make you a better pilot.

One of my favorite articles this month is "UAVs Take Flight at the U.S. Naval Academy," in which group of undergraduate students modify a Hobby Express Telemaster to accomplish autonomous flight, obstacle avoidance, air package delivery, and more.

So we've got something for everyone this month, from the annual gathering of scale aircraft at Warbirds Over Delaware to an interview with our Engine Clinic columnist and renowned powerplant expert Clarence Lee (did you know he piloted P-51s and other WW II aircraft?). Don't forget to set your online flight path to ModelAirplaneNews.com for the latest RC news, event and flightreview videos, our free weekly newsletter, and much more. We'll see you there!



EDITORIAL.

Executive Editor Debra Cleghorn >> debrac@airage.com Senior Technical Editor

Gerry Yarrish >>> gerryy@airage.com

West Coast Senior Editor John Reid >> johnr@airage.com Associate Editor Matt Boyd >> mattb@airage.com Copy Editor Suzanne Noel

CONTRIBUTORS

Jason Benson, Sal Calvagna, Budd Davisson, Don Edberg, Mike Gantt, Dave Garwood, Dave Gierke, Greg Gimlick, John Glezellis, Aaron Ham, Carl Layden, Clarence Lee, Jim Newman, Greg Poppel, Mark Rittinger, Jim Ryan, David Scott, Jerry Smith, Craig Trachten, Paul Tradelius, Pat Tritle, Rich Uravitch, Michael York, Nick Ziroli Sr.

Creative Director Betty K. Nero **Designer** Alan J. Palermo

DIGITAL MEDIA

Web Producer Holly Hansen

VIDEO/PHOTOGRAPHY

Photographer Peter Hall Videographer Adam Lebenstein

ADVERTISING

Strategic Account Manager Mitch Brian >> 203.529.4609 | mitchb@airage.com

Integrated Account Executives

Joe Corrado 203.529.4636 joec@airage.com Ben Halladay | 203.482.8093 | benh@airage.com Brian Vargas | 203.571.8850 | brianv@airage.com John Specht | 513.379.8999 | johns@airage.com

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Marketing Assistant Erica Driver Event Manager Emil DeFrancesco

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EDITORIAL OFFICE

88 Danbury Road, 2B, Wilton, CT 06897 USA EMAIL MAN@airage.com



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YOUR FEEDBACK

We love hearing from our readers: Your emails, tweets, and comments quickly let us know what you'd like to see more (or less!) of in upcoming issues and online. Here's what some of you are saying about *Model* Airplane News magazine.



Facebook Photo of the Week

Some of our most popular online posts are our picks for the "Photo of the Week." and you guys never fail to add your comments and likes. Recently, we posted an amazing flight shot of an A-6 Intruder designed and built by Mike Selby and flown by Gen. Raymond Johns, USAF (retired), as photographed by ace photographer David Hart at the 2012 Top Gun Scale Invitational at Paradise

Field in Lakeland, Florida. The 1/5-scale A-6 was a complete composite design with Mike producing all the tooling and molds for the 55-pound Top Gun entry. The 120-inch-span model was powered by a B300F turbine engine, and it tied for the High Static Score award in Team Scale with a score of 99.423. Here's another great ground shot of the Intruder and Mike's team.



AP: I lived next to McCord AFB, and the A-6 Intruder was the loudest plane I ever heard. Darn, they are loud.



DH: Hey! That's one of my old shots!



EAR: Ahh! Love me some A-6!



JT: Wow! What a great photo. I met Mike and Ray at Top Gun when they were competing with his sweep-wing



F-111 Aardvark.



AB: I remember that airplane. It has been several years. I hear Mike is no longer in scale modeling.



In Our Mailbox Saito Gas Conversion

I just learned that a local RC club member has an almost-new Saito 180 GK for sale at a super attractive price. I know that Saito four-stroke engines have an excellent reputation, but I am wondering if there is a gasoline conversion for this engine. I have given up all my glow equipment and only fly gas now. -John Philbrick, Nolensville, TN

John, we agree that the Saito line of four-stroke engines does indeed have a reputation for long-lasting quality and reliability. However, I am not aware of any conversion kits available to switch the 180 GK over to gasoline. There are aftermarket electronic-spark ignition systems with magnetic timing pickups available and even mini spark plugs that will screw right into place, but the trouble is that some of the rubber parts in the carburetor will quickly break down when exposed to gasoline. Also, switching to a gasoline-compatible carburetor would be problematic. It is possible, but I do not think it would be worth



the effort or the expense when there are so many new two-stroke gasoline engines available in the same size and power range.-GY

Correction

In our September issue, there were a few typos that reader Walt Moore pointed out in our article "How to Break In Your Engine." In the "Engine Operation" section, it should read "the engine makes one revolution for every power cycle," not two. Also, in the "Engine Terminology" section, it should state that the wristpin connects the piston to the crankshaft, not the crankcase. Finally, Walt points out that for ABC engines, the main needle valve should not be opened four turns (which is OK for ringed engines). ABC engines need heat early on in the break-in process to open up the tapered cylinder walls and make them more parallel. Very rich settings provide cooling, such that the cylinder walls don't wear in properly, remaining tapered. We agree. And with all things important, as with engine break-in, always read the manufacturer's instructions.-GY



ModelAirplaneNews.com

Scale Detailing

Recently, for our "Question of the Week," we asked what turns our readers on about scale RC airplanes and their favorite pieces of scale detail. For the diehard MAN editors, perhaps the most important detail is a scale pilot figure-one with the correct equipment and goggles. Here are some of the answers we received.

Adam Graves: I like the whole package of a truly scale airplane: working flaps, scale propeller, dummy engine, retracts—the whole nine yards. Add a functional bomb drop and a sliding canopy and you're really cooking with gas.

Keith A. Voelker: While any additional scale appearance and/or functional item will always enhance a scale airplane, one of my favorite additions is the RC pilot's ability to fly the plane in as scale a manner as possible. For most of us several yards and more away from a scale plane, the appearance of all the scale items blends into the entire plane. What is left is the entire plane's overall appearance for what it really is: namely, flying as the original full-scale plane flew.

Dan Dirksen: I really like a well-detailed cockpit. There are many models with scale outlines. working flaps, retracts, bomb drops, etc. However, the cockpit is where my eyes are first drawn to when I look at a scale model. There are so many features to most cockpits that one can spend almost as much time in the cockpit detailing as building the rest of the plane.

Hank McCabe: I think detailing is very important. To me it's personal satisfaction, even though, like Dan said, it is time-consuming. But it's well worth it in the end.

Jeb: I agree. An accurate and realistic scale pilot is the most important to me. There are many available at high prices. Unfortunately, anything priced for the average modeler is just plain ugly.







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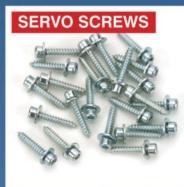


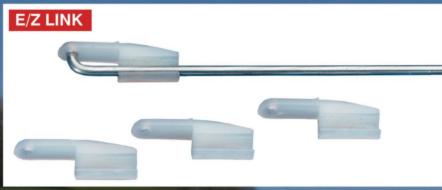












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Tips&Tricks

USEFUL HINTS FROM MODELERS | Illustrations by Richard Thompson



SNUG BOOTS

To stop worn spark plug boots from coming loose, use a Moto-tool to grind off the excess material on either side of the body and use a small hose clamp around the boot. Tighten the clamp slightly and the boot will stay put.

Jay Burns, Wallingford, CT

HANGING AROUND

A great way to increase the storage space in your workshop is to use wire–padded suit and pants hangers (from the dry cleaners) to support your model by the wings. In the basement, put a nail in an overhead joist and add some strong cord. You can bend the wire hanger as needed so that it fits precisely around the wing to provide adequate support.

Jim Newman, South Lafayette, IN



STRAIGHT TRACKING

If you want your plane to track straight, simply put an alignment rod (two brass tubes with a steel rod inserted for extended reach) in place of the axles. Poof! You now have perfect alignment of your main landing gear's axles. All you have to do is lock the landing gear into place (or the lower axle support hubs) and install your axles and wheels. Tracking alignment is important for taming your airplane's ground handling—especially during takeoff runs and landings. You'll have far fewer ground loops if your axles are aligned with each other.

Dennis Deweese, Land O' Lakes, FL



Lateral balance is important when you are trimming your model for straight and level flight. If you need to laterally balance your foam plane after a wing repair, here is an easy

trick. Place the centerline of the repaired wing on a vertical support and place finishing nails (6d to 8d "penny") on the lighter wingtip until the wing balances level. Then just push the headless nails into the wing tip and add a dab of foam filler to fill the hole. A little paint touchup and you will be ready to fly!

Dan Porter, Woodbridge, VA



SEND IN YOUR IDEAS! We want your ideas for Tips & Tricks! This month's winners will receive a *Model Airplane News* baseball cap. Send a photo or rough sketch and a brief description to MAN@airage.com or *Model Airplane News*, c/o Air Age Media, 88 Danbury Rd., Wilton, CT 06897 USA.



Pilot Projects

SHOWCASING WHAT YOU BUILD & FLY | Email entries to: MAN@airage.com



SeaMaster

Juan Vadillo, Miami, FL

Built from plans, this 48-inch-span model has foam-core wings, a Depron fuselage, and balsa-and-ply wing saddles and wing attachment points. After he covered the fuselage with Eze-Kote, a water-based finishing resin, he glassed the bottom with fiberglass and epoxy resin. The 2.5-pound model is powered by a 300-watt motor on a 3S 2200mAh LiPo.





Daddy-0 525

Gil Smetana, Tel Aviv, Israel

Built from a Stevens Aero kit and covered in MonoKote, the Daddy–O 525 is powered by a Hacker A30 and Jeti speed control and uses Hitec servos and a Spektrum DX6 radio. Gil notes that he is returning to the hobby after 30 years away and notes, "It's much more relaxing with 2.4GHz, brushless motors, CA glue, and high–quality kits. It's also nice to know MAN is still around with all its useful tips and now appears exactly every month on my tablet."



Corsair Reno Racer

Nick Ziegler, Moline, IL

Built from the Ace Simple Series kit, this model has a fiberglassed and painted wing and a MonoKote-covered fuselage. It's powered by a GForce 10 motor spinning an APC 9.7.5 prop and weighs 28 ounces. Nick notes, "It was set up for and flies fast on 3S, but on 4S, it's as fast as it looks—almost too fast! Way better than a stock .049 engine."

SEND IN YOUR PICTURES! Model Airplane News is your magazine, and we encourage reader participation. Email your high-resolution images to MAN@airage.com, with your contact information and details on your project. Every pilot we feature will receive a Model Airplane News baseball cap, and the "Pilot Project of the Month" winner will receive a Model Airplane News "swag pack."



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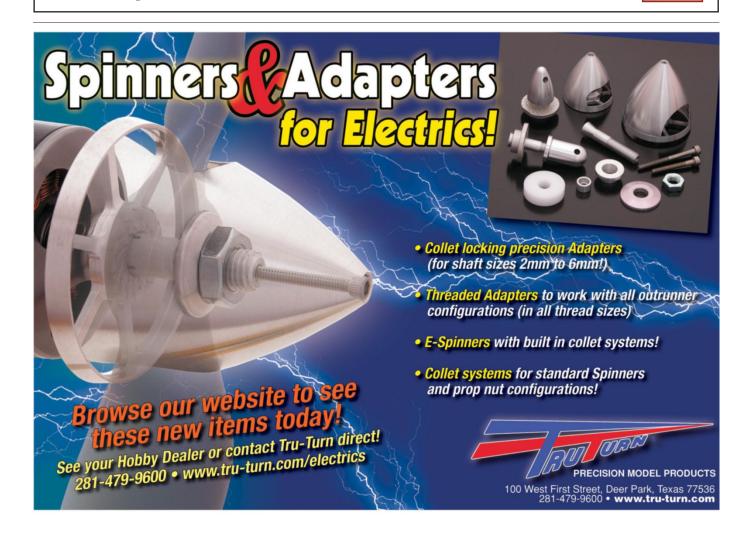


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Flightline

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Compatible with electric, glow, or gas power, this 90.5-inch-span, built-up ARF has loads of scale details, including a realistic cockpit, instrument panel, and pilot figure; operational cockpit side doors; and functional panel flaps. It costs \$299.99. Add optional floats (sold separately for \$169.99) for water takeoffs and landings! towerhobbies.com



Designed for warbird pylon racing, this 56.5-inchspan model has a reinforced firewall and wing to handle the stress of flying at high speeds. It features fully sheeted wing halves and preinstalled electric retracts, and it is intended for a .40 to .46 two-stroke or a .70 to .80 four-stroke and a 5-channel radio with five standard servos. This \$299.99 ARF is available in four color schemes.

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This classic design has been popular for more than 50 years, and Graupner's latest versions (kit and ARF) blend nostalgia with excellent flight characteristics. Ideal as a first sailplane or for competition, this 79-inch-span aircraft features laser-cut balsa parts and can be outfitted

with an optional electric power pod for powered flight. The Amigo IV kit is \$179.90; the ARF version is \$239.90.

graupnerusa.com



Spektrum Focal DVR FPV Headset

With the video quality of a premium Fat Shark headset as well as digital video recording (DVR) capability, this headset offers crisp, clear 640x480 optics that are selectable from a 16:9 to a 4:3 aspect ratio. The distance between the optic screens can be adjusted to match the spacing of the user's eyes, and the Focal DVR comes with the latest 5.8GHz Fat Shark receiver, which has an OLED display, 32 channels, and exceptional signal sensitivity and stability. It costs \$499.99.

spektrumrc.com

Blade Trio 180 CFX

This micro 3D helicopter is ready for the wildest 3D maneuvers you can try, with its 3-blade rotor head, optimized servo geometry, enhanced digital metal-gear servos, and carbon-fiber frame. A high-torque brushless outrunner main motor and Castle Creations speed control deliver the potent punch every intermediate/advanced pilot needs for thrilling backyard 3D maneuvers, and AS3X technology makes it extremely stable. This BNF Basic heli costs \$249.99.

bladehelis.com

Flightline

MP Jet Diesel .061

This high-performance powerplant sports a suction-driven crank-shaft that has modified reversible rinsing with three overflow channels and a crankshaft supported by ball bearings. The set includes a muffler. It's suitable for small models without RC speed control, like limited motor run time or control line, and not intended for beginners. The CL version is \$105.00; the RC version is \$129.00.

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Scale detail in an easy-toassemble package

BY JOHN REID PHOTOS BY LESLEY CUNNINGHAM GREENLEE

Motion RC has recently developed some larger-scale aircraft with FlightLine RC, and we were lucky to get one of their early arrivals: the Spitfire Mk IX. This EPO foam warbird has a scale outline with a nice smooth surface. The wing halves are reinforced with an interlocking plywood and carbon-fiber frame that creates a wing that's lighter and stronger than a solid foam wing. The aircraft comes painted, and there are four sets of decals that allow you to create one of two historical aircraft: that of Squadron Leader F. A. O. Tony Gaze (MA621 DV-A) or that of Lieutenant Michel Boudier (BS393 GW-Z).

The wing halves and horizontal stabilizers are removable, with just two screws each. This allows for easy transportation if you don't have a large car. On top of the fuselage is a large hatch, with easy access to a large space for all the electronics (receiver/ speed control) and the 6S 5000mAh battery that you'll supply. The servos, motor, speed control, and retracts are all installed at the factory. There are many scale details, including a scale cockpit with canopy mirror, molded-in panel lines, a 4-blade prop, scale tailwheel, wing guns, and engine exhaust pipes. The main landing gear are shock-absorbing Oleo struts, with a main wheel diameter of 85mm, along with metal reinforcement plates. This all works together with the suspension struts and soft wheels to dampen the landing forces to allow this aircraft to take off from all types of runways. This plane is perfectly suited to intermediate to advanced pilots who have some tail-dragger experience.







While there are a good number of decals, they do go on smoothly and add quite a bit of scale realism.



A large hatch grants easy access to the battery and radio compartment.



A cockpit, pilot, rearview mirror, and antenna are just some of the scale details included.



A 4-blade prop makes a nice sound in the air and is a nice scale touch.

UNIQUE FEATURES

The first thing I need to share is just how well this aircraft is packaged. All the parts are protected in bags and foam inserts inside the box, and not one part was damaged or missing. This was a welcome surprise to me, especially seeing how beat up the outside box was during shipping!

The assembly starts with attaching the tail section to the fuselage with the enclosed glue (a tube of glue is also included). The key point is to not get glue onto the pushrods passing through that joint. While waiting for that to dry,

I started on the wing. The two wing sections are joined with a carbon-fiber tube and two bolts, making it easy to disassemble if needed. The ailerons and flaps are hinged at the factory, and the servos are already installed; all I needed to do was attach the pushrods to the servo arms and control horns. This was easy to do because they are already cut to length. Final adjustments will come with radio setup.

Back to the fuselage, I installed the horizontal stabilizers. Each side is held on with two screws, making it easy to disassemble for storage or travel. The pushrods to the tail

feathers are already cut to the proper length, and this attachment was quick and easy. Assembly and attachment of the 4-blade prop was next. Each blade is secured to the spinner hub with some screws, and the spinner is then bolted onto the front of the fuselage. This is a good-looking prop; my first reaction was that it may be expensive to replace, but after looking at the website, I found that the props and spinner are quite inexpensive.

The most time-consuming process of all the building on this model was applying all the decals to give the Spitfire that final scale touch. I

spent as much time on this as I did all of the other assembly, and the result was well worth it. I attached the wing, routed the wires, and plugged in all the well-marked servo leads into my receiver, then I bound my receiver to my radio, lowered the landing gear, and centered and adjusted all the control movements. The Spitfire Mk IX was now ready for the flying field.



Smartly designed scale details are evident with the wing cannon guns. They can be pulled out for transportation and storage.

GEAR USED



Spektrum DX18 w/ AR8000 receiver (spektrumrc.com); 17g digital hybrid servos installed



MOTOR

5055-390Kv brushless and 80A speed control (installed)



BATTERY

Admiral 6S 5000mAh LiPo



PROP

16x10 4-blade (included)

IN THE AIR

The retractable landing gear are rather stout, and the

Decals, Decals, and More Decals

The kit comes with three different types of decals that all have their own way of being applied. Two large light blue sheets have peel-and-stick decals; one white sheet has a shiny plastic overlay; and the other white sheet has a flat finish and water-style decals.

For the peel-and-stick decals, which are mostly for the wing, I lightly sprayed glass cleaner on the spot where each decal will be applied. This allows me to move the decal until I have it in the right location, then I rub it from the inside out until it is all smoothed down. Use a paper towel to wick away the cleaning solution. The body decals are on the white paper with the clear plastic overlay. These are applied by peeling off the backing paper, so the decal and clear plastic oversheet stay together. This keeps the letters aligned and makes it easy to line them up on the fuselage. Place one side of the decal down on the fuselage and slowly rub out the air bubbles, working your way from one side of the decal to the other. Rub only on the decals, and don't worry about the clear plastic. Be careful as you cannot lift up or shift the decal around after it

The flat-finish water decals are used on both the body and fuselage. Cut around each decal, place it in water for 30 to



40 seconds, and pull it out. You can now move the decal on the backing paper so that one of its edges is hanging off the paper. Place that down in the correct position, and slide the backing paper off from under the decal. You can move the decal into the correct location while it is wet, but be aware that it is fragile and will easily rip apart. The best method is to place the edge of the decal in the proper position so that, when you slide out the paper, the decal lies down without needing to be moved. Dab the decal with a paper towel so that it wicks up the remaining water. Let it dry completely before touching it again. When you've finished, you will be surprised at just how much detail all those decals add to the plane.

Spitfire will have no problem taking off from the grass or solid landing strip. I checked all the control surfaces and began my taxi out to the center of the runway (in my case, a solid dry lakebed). Throttling up, I found that the 4-blade prop was responsive and put out a lot of thrust, and the Spitfire was up in the air before I was ready for it. It made for an exciting moment, but the control response made it easy to get the bird back on track. Once in the air, it was evident that this is going to be a good-flying model. My first landing was without flaps, and the Spitfire settled in well with control all the way down to the ground touching. This was impressive because we did have a good amount crosswind at the time.

has been placed down.

GENERAL FLIGHT PERFORMANCE

Stability: The Spitfire was easy to control and stable even at low throttle. The flight performance was what you would expect from a warbird.

Tracking: Tracking was very good, and the aircraft did a good job of maintaining its heading during the flights. It would basically go where it was pointed without any problems.

Aerobatics: Rolls, loops, and everything that a full–size Spitfire would do, this bird can do. The motor provides more than enough power for any scale aerobatics.

Glide and stall performance: The glide path was solid and predictable. The stalls will drop a wing but can quickly be recovered by a short blast of power or, if altitude permits, pointing the nose down and trading height for speed.



PILOT DEBRIEFING

My first flight had the 5000mAh battery in the middle of the battery rack; the Spitfire was a bit tail heavy but easy to control, so I finished the six-minute flight. On the second flight, I pushed the battery all the way toward the firewall, and on that flight, the Spitfire was solid

and stable. I have been fortunate enough to fly a number of Spitfires, and I would say that this one ranks right up there with some of the best-performing ones. It is a great value and a really nice-looking plane.

BOTTOM LINE

I would highly recommend this aircraft to anyone. Its parts fit perfectly, it has nice scale looks, and it has outstanding flight performance! This bird was easy to assemble, easy to program, and can be easily modified for a different look. For the price, you will be hard-pressed to find a better-looking and better-flying Spitfire than the Motion RC Spitfire Mk IX 1600mm. \pm

MAIRIBIRIDS OVER DELAWARE

On the flightline with giant-scale fighters, bombers, and more!

BY SAL CALVAGNA PHOTOS BY SCOTT & ROGER MCCLURG & SAL CALVAGNA







The Delaware R/C Club held its 26th annual Warbirds Over

Delaware (WOD) event at Lums Pond State Park in Bear, Delaware, on the third weekend in July. After a quarter-century of hosting this premier giant-scale RC event, one might assume that it simply runs itself. Wrong! It takes lots of planning and hard work on behalf of the Delaware R/C Club volunteers and the contest directors, Dave and Pete Malchione. They do have it down to a science-and that would be the science of fun. Like a large family reunion, modelers come from far and near to attend this yearly event. And for good reason, too: The WOD staff treats everyone like family, and this makes the entire event enjoyable.

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A pair of German Fokker D.VIIs make ready to engage the enemy!

Warbirds Over Delaware is open to the general public and attracts so many spectators that tour buses are used to transport them to and from separate parking facilities. Never fear, there is plenty of room for event participants to stake a piece of property for themselves and put up a canopy. In addition, the host club provides an enormous three-ring circus-size tent to house and protect all the models during overnight storage. There is also a well-populated vendor area where RC model-related products are sold, and the local Boy Scout troop sets up camp to prepare and offer breakfast and lunch to all attendees. One of the favorites during the hotter days is the shaved-ice vendor, and this year the line for the cool treats was constant.

Getting ready for the WW I Gaggle mass flight, Scott Reynolds starts up the Fokker D.VII belonging to his wife, Jennifer Lea.

ON THE FLIGHTLINE

The event is open to all giant-scale military aircraft



models and fighters, and any eras are welcomed. In fact,

it's common to see a Fokker Eindecker parked next to a

North American F-86 jet. This year's event was amazing,

with approximately 250 aircraft in attendance.





Over the weekend, two impressive Vailly Aviation Hawker Hurricanes could be seen flying in formation. Here, with their Battle of Britain war machines are Robert Vandermulen of Montgomery, New York, and Kevin Breen of Rock Hill, New York.



is ready for open flying. There are six pilot stations, and the volunteers work the flightline like air–traffic controllers to ensure takeoffs and landings are properly coordinated. Of course, a spotter is required for each pilot to keep the aircraft moving safely and smoothly overhead.





AIRSHOW CENTRAL

On Friday and Saturday at noon, the midday show temporarily takes over, halting open flying so that some special aerial exhibitions flights can be demonstrated. As usual, Adam Lilley starts off the show with his modified Piper Cub and a "flying farmer routine," which is spectacular. Using his transmitter, he is able to drop a wheel during takeoff and eject an aileron midflight. His flight regimen is something reminiscent of a Three

Stooges' short film, but in the end, he always manages to land successfully to the applause of the audience.

Next up is the Great WW I Gaggle, which is open to anyone with a plane of that vintage. On Saturday, 17 models took part to the delight of everyone present. Like those amazing men in their flying machines, the biplanes and triplanes flew the circuit and made some very low passes, some billowing trails of white smoke.

Getting ready for the WW I Gaggle, here is Scott Vickery and his impressive half-scale ZDZ 250cc-powered Fokker Dr.I Triplane.



Awards Presentation

Each year during the midday show on Saturday, beautiful trophy awards are presented for "outstanding contribution to the Warbirds Over Delaware event and the model aviation community." This year's honored recipients were Mike Gross Sr., Andy Kane, Tom Loveland, and the entire Tidewater RC Contingent.

Back by popular demand as part of the midday airshow, the Wonderful Warthogs formation flight kept everyone excited. Flown by Dave Malchione Jr. (tan) and Paul LeTourneau (green), these two turbine-powered A-10 Warthogs showed everyone what modern attack aircraft are all about.





Team Malchione's Corsair, built from a CARF-Models kit, makes a pass for the cameras. Powered by a Moki 5-cylinder radial engine, its exhaust tone was a real attentiongrabber.



Several local military veterans came out for the day to enjoy all the warbird action. It was an honor to thank them for their service and to learn more about them personally.

Veterans Honored

This year, a group of aging and disabled veterans from a nearby veterans' home came by bus to see all the patriotic happenings at WOD. I had the opportunity to talk with and thank each one. They were grateful for the invitation and enjoyed watching all the miniature military aircraft flights.

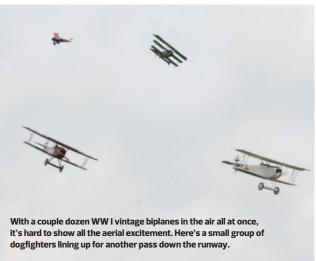
This was followed by the WW II Gaggle, which again was open to any and all pilots with WW II aircraft willing to share the sky with the others. There were a dozen models up at once, all flying lower and faster than their WW I counterparts. With loud and exciting engine sounds, both Allied and Axis models flew the pattern together.

For a taste of modern jet flight, the Wonderful Warthogs were back by popular demand. Nothing is as agile and terrifying to the enemy as the Fairchild Republic A-10 Warthog—except maybe two! Also referred to as the Thunderbolt II in honor of the WW II ground—pounding P-47 Thunderbolt, these twin—engine, straight—wing, ground—attack jets really get the job done. The giant—scale A-10s that flew the final demo flight for the noon-time show were piloted by Paul LeTourneau and Dave Malchione Jr. Both Warthogs were impressively detailed and had wingspans of 110 inches. Built from BVM/Skymaster kits, each was powered by a pair of JetCat 100 turbine engines and had thrust to spare. From their dual takeoff and climbout to their tight formation flybys,



Bombs away! This P-47 Thunderbolt was flown by Bill Fairweather and is powered by a Zenoah G45.









Paul LeTourneau's L-39 blasts off for another impressive demo flight.

these RC versions of the modern–day ground–attack jets delivered the same thrill and excitement.

Afterward, Paul LeTourneau flew a very large L–39 jet that sported a smoke system, which could make the runway disappear with clouds of smoke. Not to be outdone, Dave Malchione Jr. flew an enormous Martin B–26 Marauder medium bomber on some low passes, then proceeded to gain altitude to drop a payload of bombs at show center. Finally, Dave Malchione Jr. and Sr. flew their giant–scale CARF–Models F4U Corsairs, powered by large 5–cylinder Moki radial engines.

In another highlight, Andy Kane offered his services and his 50 percent-scale clipped-wing Cub for some lucky junior individuals who won a chance to fly his model with







This unusual Fairey Fantôme was built by Tom Brittain and flown by his son Charles. The 86-inchspan biplane warbird is powered by a DLE 35cc gas engine.



Members of Team Malchione prep their big Corsair for another sortie. Built from a CARF-Models kit, the F4U has functional folding wings.

a buddy box. These youngsters were thrilled to experience RC flight firsthand with this impressive model, and the expressions on their faces showed their excitement. Talk about a trainer—Andy's Cub spans 15 feet and is powered by a 200cc engine. Heck, I would have been happy to have the opportunity to fly it myself!

SATURDAY-NIGHT ELECTRIC MAYHEM

What would Warbirds Over Delaware be without its infamous Saturday-night Electric Mayhem? Youngsters and the young at heart wait all weekend to participate in this special end-of-the-event treat. Right after the wonderful Saturday-night barbecue, a line of antiaircraft specialists on the east end of the field man everything from slingshots and BB guns to paintball guns, airsoft guns, and potato cannons. The idea is to run the gauntlet with your old, tired, and weary foamies in order to present an airborne target. With pieces of foam departing the models, you can actually see the aircraft getting hit.

But that's not all that's happening on the field. On the west side, there's some full-contact dogfighting going on. A running battle has been going on for years now, pitting the Malchiones against the Long Island Skyhawks crew. The understanding is no quarter asked, none given; it's a

fight to the finish. Pilots try to knock each other out of the sky while taking a detour now and then to run the gauntlet at the other end of the field. This year, the Malchiones took it to another level by enlisting their family members, some as young as 18 months old, using super-soakers to attack the Long Island fliers at point-blank range. It took a swipe with a yard rake to remove my foamie Messerschmitt from the sky. Just wait till next year!

PARTING SHOT

If you like having fun, seeing old friends, making new ones, witnessing giant–scale military model aircraft in flight, and partaking in a great Saturday–night barbecue, this is the event for you. There's always plenty of action to keep those cameras clicking and lots of competition–quality models to see. As always, contest codirectors Dave and Pete Malchione and all the hard–working volunteers from the Delaware R/C Club earned their kudos this year. Operating like a well–oiled machine, Warbirds Over Delaware is more than just another giant–scale event. If you have never attended this amazing extravaganza, be sure to come next year!

For more information, check out the WOD website at delawarerc.org/warbirds.htm. $\begin{tabular}{c} \begin{tabular}{c} \begin{$

E-flite/Horizon Hobby Carbon-Z Cessna 150

A fantastic first giant-scale aircraft

BY MIKE GANTT PHOTOS BY JOHN REID

Getting into giantscale models can be downright daunting for folks. The cost, lengthy building and assembly process, and issues with transportation can be discouraging. But thanks to the designers at E-flite, we now have an 84-inch-span Cessna 150 that removes all those barriers to giant-scale entry. The super-smooth foam airframe is well shaped and fairly flawless. Reinforced where necessary, the Cessna 150 is available in Bind-N-Fly (BNF, needs just a battery and compatible radio) and Plug-N-Play (PNP, which also requires a receiver).

AT A GLANC



Carbon-Z Cessna 150 BNF



MANUFACTURER





DISTRIBUTORHorizon Hobby (horizon hobby.com)



WINGSPAN



PILOT SKILL LEVEL

Intermediate



ASSEMBLY TIME

2 hours



RADIO REQ'D

6-channel DSMX/DSM2compatible



PRICE

\$399.99 (BNF), \$379.99 (PNP)

WHAT WE LIKE

- Same day from store to air
- Excellent detailing; excellentflying plane
- Tool-less field assembly
- Plug-in wings (literally!)







UNIQUE FEATURES

Be ready for a large box to show up at your doorstep, and make sure you have ample space for unboxing and assembly. The model's tricycle landing gear setup allowed me to use a small 4-foot-long kitchen counter, with the plane's tail hanging over the edge. This proved to be a convenient and comfortable height to work on the Cessna. The model comes with illustrated instructions, which make assembly a breeze. Digital servos run



The wing struts are held with pins and clips; no tools

throughout the airplane, and the wing halves feature preinstalled flaps, ailerons, and their servos and linkages. These plug-in wings are literally plug-in: The designers have created a servo-connection system that engages all wiring from fuselage to wing panels by simply plugging the wing halves into place. After each half slides over a carbon-fiber wing tube, knob-type wing bolts hold the panels in place, making the field assembly tool-less. A large battery-access point is disguised as

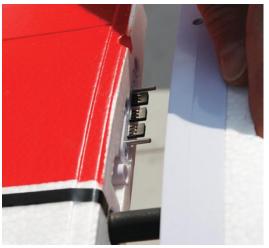


Pre-installed electronics and wiring get you in the air fast



There are zero servo leads or safety clips to fumble with as everything simply plugs in.





An E-flite 6S 5000mAh flight pack fits with room to spare. Above right: Here you can see the wing plugs just before they are seated against the fuselage.

part of the airplane's nose and a windshield. Two plastic tabs allow for an easy grip without compromising the finish. A second smaller hatch over the cabin area is where you'll find the receiver, tail servos, and light controller. The latter operates a host of LEDs, including anticollision strobes, navigation, and landing lights. Working aft you will need some thin CA glue to attach the rudder to the fuselage. There is a preinstalled wire for the rudder light. Down below, the previously mentioned landing-gear system comes to you assembled and ready to install. Hex-head screws anchor everything in place, and the nose-gear strut features shock absorption. Available options include a Carbon-Z float set for water works, landing skis for snow operation.



IN THE AIR

SAFE (Sensor Assisted Flight Envelope) Select is preprogrammed into the AR636 receiver that's included in the BNF version, and it implements pitch and bank-angle limitations and incorporates an auto-leveling feature. These features will aid new pilots and keep those overcontrolling thumbs at bay. You can assign a switch on the transmitter to turn the SAFE function on and off during flight if you prefer. All of this is outlined in the manual. The takeoff roll is smooth and easy to predict. Minimal rudder keeps the plane on the centerline until liftoff. Once the plane is rotated, any climbout angle can be achieved. Landings are easy thanks, in part, to the factoryprogrammed AS3X protocol. I like to keep the propeller spinning and adjust the elevator as needed for speed until the wheels reunite with the world. After a short slowdown roll, the plane is easy to steer back to the pits.

GENERAL FLIGHT PERFORMANCE

Stability: The Cessna 150 is about as stable an airplane you could hope for. Add in the sheer



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Flying with flaps

Flying with flaps feels different in flight no matter which type you have: plain, split, slotted, or Fowler. When engaged, flaps effectively change the camber of a wing. This, in turn, will increase lift and increase drag, and leads to lower stall and landing speeds. All good, right? Well, sometimes that extra lift may include a pitch change as an unexpected ride—along, and compensation may be needed.

- Don't experiment with your new beauty on its test flight.
- After the proper flight trimming is done and with a fresh flight pack, take the plane back up. Way up. Once you're "two mistakes" high, lower the flaps and observe the aircraft.
- If a pitch change occurs—and they do—the pilot may have to respond quickly with some elevator input. Do what is necessary to maintain positive control, and remember that you can always raise the flaps and resume flying as usual. When ready, land the airplane.
- Note the amount of elevator you added in flight. You can create a flap-to-elevator mix in your radio, which will add in a specified amount of elevator input for you when flaps are deployed.
- Finding the sweet spot takes a few flights, so be patient and adjust it to your liking. Of course, if you are a Spektrum transmitter user, you could always download the Carbon–Z Cessna 150 file to your SD card and upload it into your radio to eliminate any of the guesswork.

size of the plane and the stabilization functions and you get unbelievable stability in flight. The manual's center of gravity recommendation is perfect. While on the tarmac, this giant plane is right at home with excellent ground handling and no bad tendencies.

Tracking: Trimming was almost unnecessary; I think the test flight required three clicks for straight and level flight. As often stated, the wind hardly has an effect on flight performance with planes equipped with AS3X technology.

Aerobatics: There is more than enough power to accomplish a wide variety of aerobatic maneuvers. For some, chandelles and lazy-8s will fill the bill. More-aggressive pilots will search and find that knife-edge flight, rolling circles, and spins are well within the plane's bag of tricks.

Glide and stall performance: Remember that even though it feels light in flight, the Cessna



150 weighs almost 10 pounds. That said, the model will fly at very slow speeds and feels quite solid before it finally breaks. Glides are fairly shallow and comfortable, to say the least.

PILOT DEBRIEFING

Whether you're an intermediate pilot or a hardcore stick banger, E-flite's Cessna 150 is ready to go. It handles wind well and can do myriad maneuvers from mild to wild. If you happen to bang it up, replacement parts are readily available.

ROTTOM LINE

Giant scale is not just for the rich/retired trailer-toting gents anymore! This 84-inch airplane fits in a sedan and has plenty of power and ability to turn heads at the field, at the lake, or in the snowpack. Mild, scale-type flight can be achieved with 4-cell batteries, but the plane can be powered with 5- or 6-cell packs for more spirited flying. †





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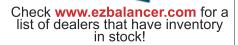
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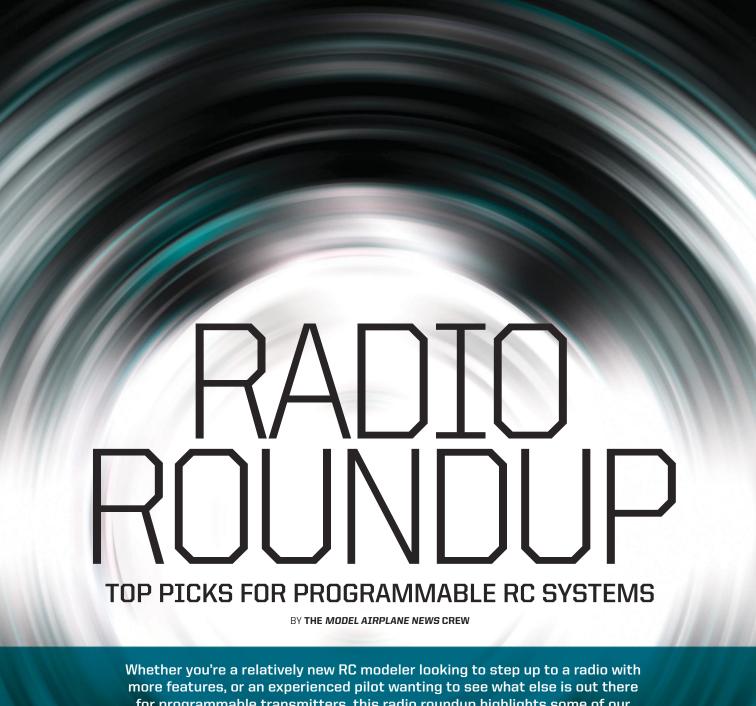
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Whether you're a relatively new RC modeler looking to step up to a radio with more features, or an experienced pilot wanting to see what else is out there for programmable transmitters, this radio roundup highlights some of our editors' top picks for midlevel systems. We selected these six radios because they're ideal for the sport flier and have lots of features for the price, making them excellent values. Each is a good investment that will pay you dividends in savings, performance, and ease of use.

Spektrum **DX6e**

For the price, the Spektrum DX6e programmable radio offers value. Using the same DSMX technology and easy-to-use AirWare programming found in the higher-priced pro-level Spektrum transmitters, the DX6e is loaded with features normally not found in this price range. For newcomers to the hobby as well as experienced RC pilots, this well-equipped 6-channel radio system is a great investment. Beginners can grow into it as their airplanes become more advanced, and sport pilots will appreciate all the bells and whistles.

The well-laid-out transmitter has all the standard two- and threeposition switches for mixes, auxiliary channels, and dual rate selection, and a Bind push button at the upper left. The on/off power switch is recessed. When switching off the transmitter, you depress the switch for about three seconds so that there are no accidental power interruptions. A stylish neck-strap hook is integrated into the case design, but a lanyard is not included. With its 250-model memory, we like the way the programming makes the memory menu easy to navigate. Only the memory slots that appear are the ones that have model settings saved to it. This means that you don't have to scroll through a bunch of empty slots or move models around should you delete any.

With an attractive price of only \$179.99 (with receiver), the DX6e is far from being just a budget radio. It is a feature-rich 6-channel radio, and it has all the features you'd expect from a

more expensive system.

SPECIFICATIONS

Model: Spektrum DX6e **Manufacturer: Spektrum** (spektrumrc.com) **Distributor:** Horizon Hobby (horizon hobby.com) Band: 2.4GHz Model memory: 250 System: DSMX, DSM2 **Telemetry: Yes** Receiver: AR610 (included) Price: \$179.98

WE LIKE

- >> 250-memory capacity
- >> Easy programming
- » Budget price



Hitec **Aurora 9X** \$339.99

The Aurora 9X has four times the resolution (4096) of the original Aurora 9, and features Hitec's triple protocol, Hopping Spread Spectrum (AFHSS), featuring bidirection and single direction, and Secure Link (SLT) 2.4GHz technology. The 9X can be used with any transmitterready (Tx-R) model using the SLT protocol as well as

allowing selection from the G1 and G2 Adaptive Frequency Hitec's Optima, Minima, and Maxima receivers.

adjusting the radio's features is easy and intuitive. From the custom submenu to collect your favorite functions and mixes to assigning switch functions and adding telemetry function for increased in-flight awareness,

the Aurora 9X provides complete control.

The Aurora 9X has a dual processor, for improved (low-latency) interface response adjustment. There are four 3-position switches and three 2-position switches, all assignable. Everything about navigating its program menus and

speeds of 7ms, as well as an extensive telemetry monitoring system and more than 30 additional programming enhancements. Like the previous version, the 9X retains the same easy-to-read, 5.1-inch-wide backlit touchscreen. All the switches are dynamically assignable for the ultimate in easy setup and function placement. Available with a variety of receivers and as a "transmitter-only" package, you can order the 9X exactly the way you want it. Another neat feature is an internal vibration device, so you can choose the feel of the transmitter's programming cues and warnings. Most of the mixes have an optional 7-point curve

MAN Test

COND-1





83% NTEG-T 03:09:0

Model: Aurora 9X **Manufacturer:** Hitec RCD (hitecrcd.com) **Distributor:** Tower Hobbies (towerhobbies.com) Band: 2.4GHz Model memory: 30 System: AFHSS (single- and bidirection) and SLT Telemetry: Yes Receiver: Not included Price: \$339.99

WE LIKE

- >> Touchscreen interface
- >> Easy setup and programming
- >> Custom screens



SPECIFICATIONS

Model: Taranis X9D Plus Manufacturer: FrSky (frsky-rc.com) Distributor: HobbyKing (hobbyking.com) Band: 2.4GHz Model memory: 60 (expandable with SD card) System: ACCST Telemetry: Yes Receiver: X8R (included) Price: \$230.48

WE LIKE

- >>> Clean, ergonomic design
- >> Fully programmable switches and functions
- >> Unlimited programming

FrSky **Taranis X9D Plus**

If you like flexibility and the ability to configure your hardware to your particular tastes, then the FrSky Taranis X9D Plus is for you. Control assignments, transmitting format, and even the internal firmware can be tailored to fit your individual tastes. Distributed by HobbyKing, the Taranis is a comfortable-to-hold 2.4GHz transmitter capable of up to 16 channels. The transmission format is the ACCST frequency-hopping spread spectrum, and it's compatible with FrSky's X series, D series, and V8-II series receivers. With X and D series receivers, the Taranis can receive real-time telemetry and will warn you of signal degrades. The X9D also includes a module port that will accept Spektrum or OrangeRX modules.

Dominated by a large backlit LCD display, the X9D has a variety of two- and three-position switches, sliders, and knobs, all of which can be configured to control any function. The radio offers both voice and vibrating prompts to keep you informed about flight time, low-voltage alarms, and selected flight modes.

Programming is straightforward; you can use the setup wizards or enter settings

manually. The X9D's mixer capability is truly amazing. With 64 programmable mixers, you're unlikely to ever run out. Telemetry-capable receivers, like the X8R, include a jumper so that you can select the binding mode. Once bound, the receiver is assigned to that model memory, making it nearly impossible to select the wrong model. Including a completely open programming structure, the Taranis X9D Plus requires a little more study and initial setup than some other computer radios, but once you master the programming and operation, there's almost nothing it can't do.



Futaba **10J**

\$319.99

The Futaba 10J boasts an array of features usually found only on high-end, pro-level transmitters. It has a modern case design with no visible antenna and a backlit, easy-to-read main display. The 2.4GHz FHSS system includes multirotor, airplane, helicopter, and glider programming with user-updatable software and a 30-model memory as well as multirotor programming. The 10J is easily within the budget of the average pilot and even for first-time pilots.

The 10J is available in two versions: Airplane (10JA) and Helicopter (10JH), both of which have the same programming. The difference is in the switch layout and the throttle—the heli version having a smooth throttle versus the airplane version's ratcheting throttle. No servos are included, allowing the pilot to choose the appropriate ones for the aircraft. In addition to the 10J transmitter, a R3008SB receiver, switch harness, neck strap, and instruction manual are included. The system is compatible with all Futaba FHSS receivers. To take advantage of the telemetry features, a T-FHSS Air receiver, such as the included R3008SB, is required. The default communication system is T-FHSS but can be switched to S-FHSS for other receivers without telemetry. A variety of sensors are available to help you remotely monitor the aircraft's condition. No sensor is needed for the receiver voltage data. For aircraft with many servos, you can use the S.Bus/S.Bus2 system to simplify servo wiring and clean up their installations.

S.BUS SX ID= 024-32545 PREAD MUNICIPAL PRESET DEAD # 0.36 CHAND REVE NORM 0.00 NEUT > EPA 100.0(L/R)100.0 S.BUS SX 1 2 ID= 024-32545 MSING DURITE DRESET SPEDD INH STRE ▶ 1.0 STARP BOST▶ INH 3.0 SMOT NON DAMP▶ 128



mz-12 Graupner 51 HOPPING.TELEMETRY.TRANSMISSION

SPECIFICATIONS

Model: HoTT MZ-12
Manufacturer: Graupner
(graupner.de)
Distributor: Open Hobby
(openhobby.com)
Band: 2.4GHz
Model memory: 20
System: FHSS
Telemetry: Yes
Receiver: GR-16L
(included)
Price: 5149.00

WE LIKE

- >> Budget price
- Integrated telemetry screen
- >> Easy programming



Graupner **MZ-12**

The MZ-12 is packed with many amenities. The switches are placed for ease of access, and polished hex-head fasteners lock on the silver gimbal surround plate. Digital trim tabs and eight directional/selection buttons handle all adjustments and program setups. The short hinged antenna can be pointed straight out or folded out of the way at 90 degrees to the case. The silver power switch has raised tabs for positive touch activation. When powered up, the main logo illuminates in red and the 128x64 backlit screen lights up in blue. Sixteen bits of info are listed on the main screen, displaying

transmitter/receiver signal strength, radio/receiver voltages, timers, trim settings, trainer status, model type, and more. Two operating instruction manuals are mostly filled with screen shots and info about navigating through them. An 8-channel, lightweight receiver (GR-16L) is included, along with a neck strap.

Built-in telemetry includes an integrated screen in the menu list for easy access. You can see the receiver's (in-flight) operating voltage and signal power among other important flight data, with optional modules/ sensors. The MZ-12 has two extra digital channels when this combo is used, so more receivers can be connected to the primary receiver, allowing you to have up to 32 channels. The unique Graupner HoTT transmission system features built-in telemetry right out of the box. Programming is intuitive.





FlySky **i10**

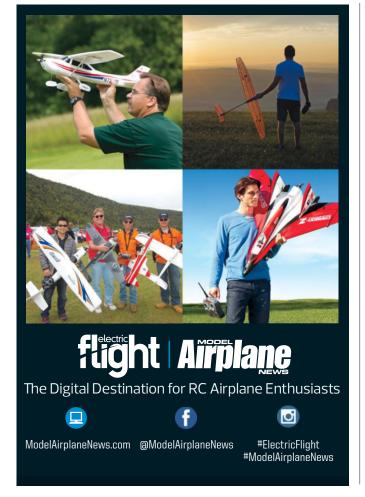
Distributed by Diamond Hobby, the FlySky FS-i10 10-channel radio includes a 10-channel telemetry-capable receiver and four telemetry sensors—one each for temperature and voltage and two for rpm. Other goodies include an I-Bus receiver, extensions for the sensors, a bind plug, and reflective foil/magnets for the rpm sensors. A 55-page instruction manual is on the included CD.

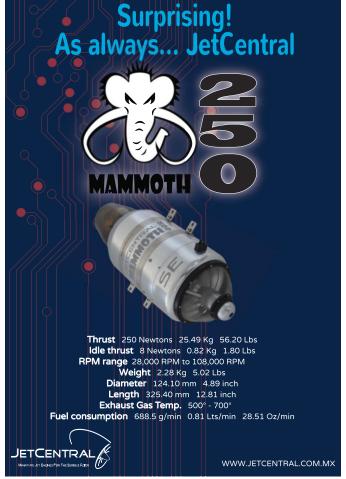
The first thing you notice while handling the transmitter is how incredibly thin it is. It's probably half the thickness of a normal transmitter, which also makes it very light. The interface screen is front and center, and presents a lot of information without being too busy.

Under the transmitter battery is a port for an SD card. If desired, an external USB charger and extra transmitter battery pack are available. Using a 2.4GHz AFHDS 2A (Automatic Frequency Hopping Digital System 2), the radio is designed for fixed-wing planes, helicopters, and gliders. Loaded with features that you normally wouldn't see in a budget radio system, it has a 20-model memory, which is virtually unlimited with the use of an SD card. The high-resolution color home screen has a touchscreen interface, and a stylus (stored in the transmitter's bottom back right corner) is included to navigate the menus. Using the interface quickly becomes familiar as it's much like a smartphone. Eight switches (two three-position and six two-position) and three rotating knobs and slider switches are all assignable. \pm









Multiplex Extra 330SC GB

Fly extreme 3D with this receiver-ready model

BY MIKE GANTT PHOTOS BY JOHN REID



Gernot Bruckmann is one of the most experienced guys out there at designing and flying successful 3D airframes, and Multiplex teamed up with him to create this awesome Extra 330SC model, which is actually licensed by Extra Aircraft. Some of the most exciting types of RC flying, 3D maneuvers demand that an airframe be almost indestructible and able to withstand high-G loads, and this new Elapor airframe delivers.

AT A GLANCE



Extra 330SC GB



MANUFACTURER Multiplex (multiplex-rc.de)



DISTRIBUTOR

Hitec RCD (hitecrcd.com)



WINGSPAN 45.3 in.



PILOT SKILL LEVEL

Advanced



ASSEMBLY TIME Less than one hour



RADIO REO'D 6-channel

POWER REO'D



3S 2600mAh LiPo



\$400.00 (receiver-ready)

WHAT WE LIKE

- Superbly designed airframe
- Extremely low assembly time
- Awesome-looking scheme
- Amazing power-to-weight ratio on 3S packs







UNIQUE FEATURES

I tested the receiver-ready version of this model, which comes with all hinges installed except the rudder. Hinging the rudder requires that you simply snap it to the vertical stabilizer's hinge halves. When the two make positive contact, there will be a definite click. Mine fit together flawlessly, and the result is a smooth-operating control surface that can be easily removed if needed. The other hinges are wide, flat plastic CA types with four per aileron and four on the horizontal stabilizer/elevator. The tug test verified that all were glued in well at the factory. Control connections are completed with long servo arms, metal rods, and double plastic control horns, all of which were factory positioned, glued, and ready for final adjustment. Setscrews make setup a breeze. With power on and all controls at neutral, you can quickly and easily position your surfaces by hand and tighten up the screws. Adding a drop of blue thread-locker to the screws doesn't hurt.

The landing gear looks super cool and is made out of carbon fiber. It arrives as a complete unit with mating undercarriage fairings/cuffs, foam wheels, and plastic wheel pants all preassembled. Two larger-gauge hex-head fasteners anchor it to the fuselage. For the tail gear, a bent wire and a foam tire keep the rudder from dragging on terra firma. All airframe parts fit together with tight tolerances. The wings are two parts, which are reinforced with more carbon fiber. A carbon-fiber-reinforced

polymer wing tube keeps the wing halves lined up and from doing the "taco." It's probably worth mentioning that each aileron/counterbalance makes up more than a third of each wing! A similar stabilizer tube is also employed, while a plastic screw secures the horizontal tail in place. Rather than using the supplied screw, I glued my stabilizer to the fuselage, as I have no intentions of disassembling this model.

The fuselage has a large hatch, held in place with magnets and a mechanical latch. A tinted "glass" cockpit shows off a preplaced pilot bust and dashboard with flight instruments/gauges at the ready. The factory-applied decal design is stunning; a big thanks goes out to the designer and applicator. For power (thrust for 3D), there is already a motor and speed control installed. Check the supplied propeller for balance, install it, and screw on the supplied spinner. The sample prop was well balanced out of the box.

IN THE AIR

Short grass is good, and a paved runway is ideal. Hardly any room is needed; you could fly this plane in a park baseball diamond. Depending on your flying style or frame of mind, this plane can do a scale takeoff as smooth as silk or you can pull up and go into an "afterburner"-type vertical climbout. The thrust generated by the Permax power system pulls the plane up in a hurry, so hardly any rudder correction is need during the rollout. Landings are almost as easy. Keep the prop turning and wings level while using



Gernot, is that you in there? The included pilot bust is ready for action.



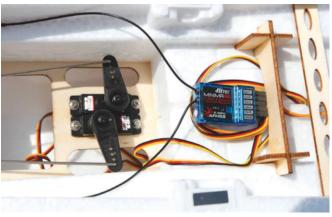
A push-pull rudder system is employed. The tail wheel works well making taxiing an easy task.



Short and simple, the linkages are easy to set up and adjust.



Carbon-fiber landing gear offers solid ground handling.



Plywood reinforcements and Hitec metal gear servos keep this plane solid in flight.



Mixology

Center-of-gravity location, control-surface throws, rate setup, and more good info is typically found in the manual, so I generally rely on it. The recommended settings are great for starting points, but if you've ever wondered why some pilots' planes seem to fly so much better than others-even when employing the same airframe-it could be the mixture of things. The Multiplex 330SC instructions provide some mix values, and when used, they provide pilots with that extra assistance

Mix #1. Rudder/Elevator

So you roll to knife-edge and are thumbing away wondering, "Why am I fighting to keep it here?" To answer the question, first identify what is happening: Is the plane pulling toward the landing gear or canopy? If there is a tendency to pull toward one side or the other, the method of mixing some opposite elevator input to counteract this flight condition will lighten your thumb load. Pulls to canopy?: Create a mix so that, when you input rudder, the elevator will automatically move down, compensating for you. Pulls to gear?: Create the mix to add up-elevator. The percentage you add is key and can best be found through experimentation. Start with a low percentagemaybe 3 to 5%—and adjust as needed.

Mix #2. Rudder/Aileron

Your test flights revealed some adverse roll during the knife-edge condition; by mixing some opposite aileron input when rudder is applied, pilots can decrease even more thumb load. Again, test and retest with different values (percentages) and find what works best for you. When you get it nailed down, your knife-edge flight should almost be doable one-handed.

small elevator inputs to control the speed and angle of attack. Harrier landings are easy to do, but greasy three-pointers look cool too. A short roll follows touchdown and after the speed bleeds off, planting the tailwheel down with full up-elevator makes for easy taxiing back to the pits.

GENERAL FLIGHT PERFORMANCE

Stability: Aircraft designed for aerobatics are not typically designed to be stable; instability is what allows us to do incredible aerobatic maneuvers. That said, when flown in a normal pattern, the plane feels fine and flies like a 3D ship should.

Tracking: The size of the model is deceiving as it tracks better than predicted. Perhaps the slightly elongated tail moment and servo torque power aid this endeavor.

Aerobatics: This is where the collaboration

among one of the best pilots, best aircraft companies, and best model manufacturers really shows itself off. The roll rate spins like a drill, and the rifle rolls are blinding. Any maneuver is possible—dream it and you can do it.

Glide and stall performance: Flying poststall in high alpha is more proof of how well this plane is designed. The thick wingtip airfoil keeps wing rock at bay. Glides aren't like a trainer, but



RADIO

Hitec Flash 8 and Minima 6E receiver (hitecrcd.com); four HS-82MG servos (installed)



Permax 3520-920Kv; Multiplex BL-55 (installed)



PROP

14x7 electric (included)



FlightPower 3S 2550mAh or 3S 2200mAh LiPo (flightpower batteries.com)

they're not too steep; the controls will retain their effectiveness, so just keep a little power on to extend your slip.

PILOT DEBRIEFING

There was some coupling in knife-edge, and the building instructions give you good mix values to start with. You should also know that the control surfaces are extremely powerful even on low rates. There is an option to increase the throws (outlined in the manual) to a "professionals-only" level and is how the estimated rate of three-plus rolls per second was achieved during the flight tests.

BOTTOM LINE

The Elapor foam airframe is stout, forgiving, and easy to repair if necessary. With some low-cost 3-cell batteries, you'll be flying all day and practicing your hardcore "huck" moves down low without worry. The provided power system is perfect, delivering smooth and "excessive" thrust (if there is such a thing!), making any poststall maneuver or tumble-type move doable. The bright color scheme is art in the air and makes orientation easy. You'll want this one! ‡



The members of the U.S. Naval Academy team include Midshipmen 1st Class (seniors) Connor Dittmar, Thomas Moore, Timothy Naski, Matthew Sims, and Luke Redito, along with Midshipmen 2nd Class Daniel Jackson and Nikola Pejovic.

UAVs Take Flight at the U.S. Naval Academy

A Telemaster becomes a mission-compliant drone

BY THE MODEL AIRPLANE NEWS CREW

hile steeped in tradition, the U.S. Naval Academy in Annapolis, Maryland, is also involved in the 21st-century battlefield's increasing use of drones. The Academy's Weapons and Systems Engineering Department is now focusing on the development,

implementation, and control of unmanned aerial vehicle (UAV) systems. And just like the evolving battlefield, the Academy's curriculum is also evolving to match the everincreasing pace of drone warfare.

One project that the department is supporting is an unmanned autonomous aircraft designed to compete at the Association for Unmanned Vehicle Systems International Student Unmanned Aerial Systems Competition. According to Midshipman 1st Class Luke Redito, the competition is held each year at Webster Field near the Naval Air Station, and is intended to help foster interest in unmanned aerial systems and stimulate interest in this technology.

Each drone must be built and flown by a team of undergraduate students and comply with competition protocols, including sharing of mission telemetry, autonomous flight operations, obstacle avoidance, object detection and classification, localization, and air package delivery. The team members are all systems engineering majors, with the exception of Redito, who is majoring in political science. Due to his experience as an avid RC airplane hobbyist, he was brought onto the team to serve as the airframe lead and test pilot.







THE AIRCRAFT

The team decided to base their entry on the Senior Telemaster, a perfect choice for integrating autonomous aircraft systems. They used a Pixhawk unit that allows programming so that the aircraft can fly a predetermined waypoint course via specified GPS coordinates. The onboard flight controller is linked to a standard 9-channel receiver controlled by a Spektrum DX9.

The team installed a downward–facing high–resolution camera and a wide–angle camera for the search–and–detection and image–recognition requirements. This data is then transmitted via a Ubiquiti Bullet M2 2.4GHz radio to a ground–station laptop. The modular installation approach allows different flight boards to be programmed for different missions. The main modification made to the standard Telemaster was to convert it from tail–dragger to tricycle landing gear to increase ground clearance for swapping out different camera lenses.

Redito reports that the modified Telemaster flew splendidly. The airframe allows for future

development, including a gimbal-mounted camera for more directional authority while searching for the image targets and a drop mechanism for the water-bottle-drop portion of the competition. Looking to the Academy's 2018 academic year, the team is considering building their own airframe out of foam with similar design aspects as the Telemaster and using a carbonfiber rod as the fuselage with a carbon-fiber or balsa flight box to contain the Pixhawk, receiver, and camera processing boards.

This project has great potential and has been a wonderful introduction for the new generation of UAV pilots learning the challenges of modern drone warfare, with the help of the RC hobby and model aviation. Although a system failure knocked them out of the 2017 competition, the team has revised their competition plane and will again compete in 2018. For more information and project updates, check out the team's website at usna.edu/SUAS/index.php.

"IN THE 2017-2018 ACADEMIC YEAR, WE WILL CONTINUE FINE-TUNING OUR AIRCRAFT AND SYSTEMS SETUP, WORKING ON AUTONOMOUS TAKEOFF AND LANDINGS AND WAYPOINT NAVIGATION."



We had a chance to speak with the test pilot, Midshipman 1st Class Luke Redito, to get a feel for what it's like to fly in the UAV competition. Here's what we learned.

MAN: Tell us what a typical flight is like during the competition. How much is you piloting the model and how much is autonomous?

Luke Redito: A typical flight is supposed to be mostly autonomous: takeoff, landing, in-flight maneuvers, et cetera. A safety pilot is in place to take over manual control in the event that something goes awry. Currently we are successful operating with waypoint navigation, but takeoffs and landings are done line-of-sight by the pilot.



What are your drone's specs?

The wingspan is 97 inches, and the overall length is 62 inches. The ready-to-fly weight is 12.5 pounds, and we are running two 5S 5000mAh batteries in parallel. The motor is an eRC 60-size brushless outrunner that turns a 17x10 E-propeller. The speed control is an E-flite 80-amp, and we are using four Hitec HS-322HD servos. Additionally, we are

using a Spektrum AR9020 receiver and a DX9 transmitter.

Can you give us some specifics about your camera and gimbal setup? We are currently working to find a gimbal that will work with our airframe



since we are limited in space. The current setup is with a downward-facing camera that is mounted vertically in our airframe. We 3D-printed the mounts to fit our cameras. We built in some vibration dampeners to ensure high-

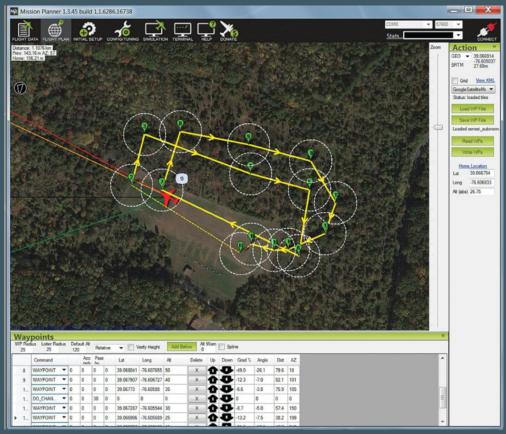
quality, vibration-free photos. We also have a wide-angle camera that is of lower image quality, but it is good enough for image recognition.

What safeguards are built into the flight system?

At any point in a flight, the safety/test pilot can take control of the plane with a flip of a switch on the transmitter. This is a requirement for the competition and for our own peace of mind. We also have a wireless battery monitoring telemetry system that we can see on our ground-station laptop to warn of any battery malfunctions, so we can land immediately.

What are your plans for 2018?

In the 2017–2018 academic year, we will continue fine-tuning our aircraft and systems setup, working on autonomous takeoff and landings and waypoint navigation. We also want to begin flight testing our new composite construction airframe, which will be more robust than the balsa Telemaster. ±



RISE Vusion 250 Racer FPV-R

Ready, set, get into **FPV** racing now!

BY JOHN REID PHOTOS BY CHERYL VOMACKA MALTBY

The RISE Vusion series of quads opens up the world of first-person-view (FPV) flying to the pilot who is looking to dabble in drone racing. The new Vision 250 Racer FPV-R is great for the beginner and can easily grow with fliers as their skills improve. This fully assembled quad has injection-molded construction and is ready to go out of the box-just add a transmitter and goggles.

AT A GLANCE



MODEL

Vusion 250 FPV Racing Drone



MANUFACTURER RISE

(explore-rise.com)



DISTRIBUTOR

Hobbico (hobbico.com)



TYPE

SIZE 250mm SIZE



ASSEMBLY TIME

None



FLIGHT DURATION

(4 to 5 minutes



CAMERA QUALITY

FPV and video



PRICE

\$219.99

WHAT WE LIKE

- Ready to go out of the box
- Easy to fly, with three flight modes
- Can take a hit and keep flying
- Stable flight performance







Above: The bottom slides out and allows for easy access to the battery compartment. Right: The FPV camera is easy to flip up, so you can get a clear view of the racecourse.

HIGHLIGHTS

When I opened up the box, the first thing I noticed was how nice this bird looks and the minimal amount of assembly I would need to do on it. The only thing I actually needed to install was the video-transmitter antenna, and that required no tools at all. LED lights are installed on all the arms to help with orientation—white in the front, red in the back. The arms and body are a solid, high-grade, injection—molded plastic that is resistant to crashes, but if you do experience a really hard impact, all of the parts are available and easy to replace.

The power system is stout and has no problem getting the Vusion 250 up to speed. Each of the arms houses a high-frequency speed control with OneShot125 programming and a 2280Kv brushless motor. All the wiring is neatly housed in the arm, and only two bolts need to be removed to replace the arm. In addition, a 600TVL FPV pop-up camera is built into the top of the body. To adjust the camera to the angle you prefer, just press on the back. The built-in DVR will accept up to a 32GB micro memory card, and can record video and take photos if you are using the compatible RISE J2000 radio, which has dedicated buttons for





video recording and photos. Also included in the box is an extra set of props, a 3S 1500mAh LiPo battery, and a manual.

AERIAL RECAP

Turn on the transmitter, power up the Vusion 250, and let it sit there on level ground for at least 10 seconds so that the gyros can get set up. Then hold the left stick down and to the right for a second or two, and that will start the motors (down and to the left stops them). From there, center the stick and then slowly advance the throttle to get the Vusion to lift off.

Once in the air, the Vusion 250 has three different flight modes that you can fly with, making this the perfect racer for the novice all the way up to the advanced pilot. In mode one,

Upgrade your performance with APC Aftermarket Propellers!

Replacement props now available for the 3DR Solo and DJI Phantom.

Visit the APC Prop Website for more details about our efficient, high performance, balanced multi-copter propellers.





Proudly made in the USA!

Providing superior quality, unmatched variety, and excellent service since 1989.

WWW.APCPROP.COM (530) 661-0399

APC propellers are also available from your favorite online dealer or local hobby shop.













Above: The plug is within easy reach, allowing for quick and simple connections. Below: -The top plate also slides off for easy access to the flight-controller board.



you have auto-level stability, a mild roll rate, and a limited tilt angle, making this the perfect starter mode. Mode two still has auto level, but it allows a higher roll rate and tilt angle, allowing the pilot to race. In mode three, the pilot has complete control and the quad is extremely maneuverable. There is no auto level, and the pilot is responsible for every movement and getting the quad back on track. If you want to do aerobatics, this is the mode for you.

BOTTOM LINE

The RISE Vusion 250 FPV is the perfect racer for the pilot who just wants to fly and race. With no building, the only time constraint is waiting for the battery to charge. This is an easy and fun bird to fly and should give you many hours of fun racing. My recommendation is to get some more battery packs; you will want more time in the air on each of your flying outings. ±

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Making the Grade

How to study for and pass the FAA's Part 107 Exemption exam

TEXT & PHOTOS BY **JOHN REID**

When I tell fellow RC pilots that I have my remote pilot's license, the first question they usually ask is "Was the unmanned aircraft test hard?" This is a subjective question, and much will depend on yo r background and experience with full-size aircraft. If you've never had any experience with any type of aircraft and have never heard the term "controlled airspace," then the test may be somewhat difficult, even after you take a class and study for it. But if you have any experience with flying and airspace, that knowledge will make it much easier to understand the concepts that relate to the questions on the test. If you already have a pilot's license, of course, then this should be an easy test. So my answer is always "It depends."



As a magazine editor, I am used to deadlines, so my first task was to schedule the test two weeks out. Once that was done, I had a study timeframe in which to find all the information I needed to learn it and pass the test.

Getting Ready

In this article, I will cover the ways I studied for the test and some tricks I have learned over the years to successfully pass any test. The first piece of advice—and this may seem obvious—is that you must know the material. This means you need to understand the material, not just be aware of it. Knowing that there is a difference, for example, between Class B and Class D airspace is not enough; you need to understand the difference between them and the exact definition of each. My objective was to learn and know the definitions of all the items that might be included on the test.

If you aren't already a licensed pilot or aren't very

familiar with airspace regulations, I recommend that you attend a seminar or take an online class that specializes in the unmanned aircraft test. This is the best way to learn everything you need to know for securing your Part 107 license. But when I considered my previous knowledge and my time schedule, I decided to go another route.

V ADDRESS

UNITED STATES OF AMERICA AND PROPERTY OF TRANSPORTATION . PEDERAL PURPLE PROPERTY OF TRANSPORTATION .

I started by checking out the recommended Federal Aviation Administration (FAA) website (faa.gov/training_ testing/testing), which has two downloadable PDFs in the Remote Pilot Certification section: the Airman Certification Standards for Unmanned Aircraft Systems and the Remote Pilot Study Guide. They are designed for the Part 107 test and have good information, but I found the PDFs to be rather lengthy and somewhat hard to wade through. There is also more information about flying in general than you need to know to fly a drone safely in U.S. airspace (and pass the Part 107 exam). The guides cover many subjects about flight in great depth, so if you really like to read, they will teach you everything you could ever want to know on the subject of aviation. Otherwise, pay close attention to the sections on airspace and reading navigational maps.

Other Sources

After perusing the material on the FAA site, I decided to head over to YouTube. Many of the videos were, to say the least, a waste of time, but I did find one by Tony and Chelsea Northrup that featured a photographer who took the test and passed. They also offer a study guide that has a lot of good information, and I found it to be a valuable resource. Included in this guide are numbers (minimum and maximum), facts you need to know, weather information, METAR (Meteorological Aerodrome Report) data and weather abbreviations, charts, controlled airspace definitions, links for chart-reading tips, METAR and TAF (Terminal Aerodrome Forecast) acronyms, and decoding video links. I've posted the video online at ModelAirplaneNews.com/part107.

IF YOU ARE SELFDISCIPLINED, YOU
CAN PASS THIS TEST
BY USING STUDY
MATERIALS THAT ARE
EASILY ACCESSIBLE
ONLINE. IF, HOWEVER,
YOU PREFER TO HAVE
A LITTLE HELP WITH
YOUR PREPARATION,
THERE ARE A NUMBER
OF FINE SCHOOLS
THAT WILL GUIDE YOU
THROUGH IT EVERY
STEP OF THE WAY.

Practice Makes Perfect

After studying all the information I could find on the FAA site and YouTube videos, I headed over to a couple of free practice-test sites. One of the best can be found on the 3D Robotics website (3dr.com), where you can answer sample test questions and then see all the correct answers. Another good one is on the Rupprecht Law website (jrupprechtlaw.com); it provides the correct answers along with detailed explanations. It's a huge help to be able to take a practice test in advance of the actual test. In addition, you can take the tests repeatedly to help boost your confidence.

(Refer to Figure 20.) Why would the small flag at Lake sectional chart be important to a Remote PIC?

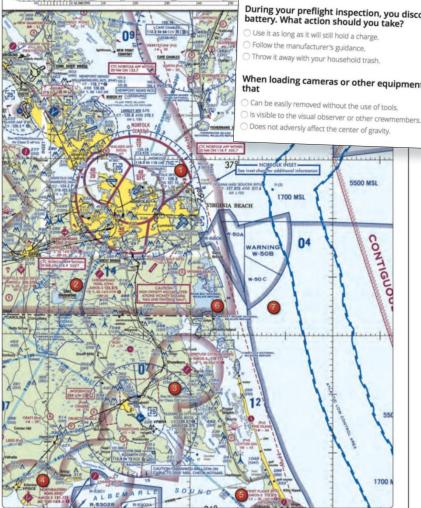


FIGURE 20.—Sectional Chart Excerpt. NOTE: Chart is not to scale and should not be used for navigation. Use associated scale.

Questions 1-10

(Refer to Figure 20.) Why would the small flag at Lake Drummond in area 2 of the sectional chart be important to a Remote PIC?

- The flag indicates a GPS check point that can be used by both manned and remote pilots for orientation. The flag indicates a VFR check point for manned aircraft, and a higher volume of air traffic should be expected
- The flag indicates that there will be a large obstruction depicted on the next printing of the chart.

According to 14 CFR part 107, an sUAS is a unmanned aircraft system weighing

- 55 kg or less.
- O Less than 55 lbs
- 55 lbs or less.

A person whose sole task is watching the sUAS to report hazards to the rest of the crew is called

- O Visual observe
- O Remote-PIC
- O Person manipulating the controls

(Refer to figure 15) In the TAF from KOKC, the clear sky becomes

- overcast at 2,000 feet during the forecast period between 2200Z and 2400Z.
- overcast at 200 feet with the probability of becoming overcast at 400 feet during the forecast period between
- overcast at 200 feet with a 40% probability of becoming overcast at 600 feet during the forecast period between

During your preflight inspection, you discover a small nick in the casing of your sUAS

When loading cameras or other equipment on an sUAS, mount the items in a manner

Knowing how to read aeronautical charts, like this one on the left, will go a long way to helping you pass the test.

What Is on the Test?

Before taking my test, these were my main questions: Did I study enough? Did I study the right items? Should I have memorized everything in the recommended study materials on the FAA website? On my test (and please keep in mind that each test has different, randomly selected questions), the following were the main subjects that were covered. First and foremost was airspace, and most of the questions on my test related to this subject. Along with this was the ability to read and understand aeronautical charts. There were a few questions on who is responsible for various things during a drone flight (hint: it will almost always be the Pilot in Command). Finally, some questions were devoted to the decoding of TAF reports and METAR data and weather in general. If you go into the test with a firm understanding of these items, you will most likely pass.

Finding a Test Center

The Part 107 exam, or aeronautical knowledge test, must be taken at an FAA-approved Knowledge Testing Center. To find one near you, do an online search or contact the providers: CATS (Computer Assisted Testing Service)—800–947–4228; PSI Services—800–211–2754. The centers charge approximately \$150 to take the exam. You will need to bring along payment and an acceptable form of identification, such as a driver's license.

Test Day

I arrived at the testing center just about an hour before the test was scheduled to begin so that I could have some time to go over my notes and review some of the study guides. Before I take any test, I like to get my head in the game by looking at words and items that relate to it. This just puts it all fresh in my mind so that when I see the same words on the test, they are easier to recall.

When you sit down at the computer desk to take the test, organize everything (and be sure that you've brought along a simple calculator, which you are allowed to have—there is no reason to miss a question because of a math miscalculation). You have two hours to take the test; you'll have two minutes per question, which is plenty of time, so don't let that bother you. Read each question carefully because some of the questions are written in an unusual way; you may need to read the question two or three times before you understand what it is being asked. Don't rush—be sure to read the whole question. Carefully read the question in its entirety and all the answers before selecting one. Take your time!

If there are questions that you just don't know or understand, the test allows you to mark them so that you can easily come back to them at the end. Do that, and come back to them at the end. This accomplishes two things. First, by going through and answering all the questions you know, you'll gain confidence in your knowledge and reduce any test jitters you may have. Second, after reading additional questions and answers, you may be better able to answer the questions you temporarily skipped. In many cases, one of the three possible answers can be quickly eliminated because it makes no sense. Therefore, if you are unsure about a question, use logic to eliminate one of the answers and give yourself a better chance of answering correctly.

If you have time left at the end of the test, go back over everything just to make sure you did not misread any questions and that you did, in fact, check the answers you meant to check. One bit of advice: If you go back over your test and



Flight Training

There are many training schools specifically designed to teach you everything you need to know to pass the Part 107 test. Here are just a few:

Academy of Model Aeronautics (AMA)

amaflightschool.org/fly-robotics.com FAA Part 107 Preparatory Course Online training

Aircraft Owners and Pilots Association (AOPA)

Frederick, MD aopa.org FAA Part 107 Preparatory Course In-person training

Drone Pilot Ground School

Nashville, TN dronepilotgroundschool.com FAA Part 107 Preparatory Course Online training

Drone University USA

Sacramento, CA droneuniversityusa.com FAA Part 107 Preparatory Course In–person training

Eye in the Sky UAS Training Academy, Nevada Institute for Autonomous Systems

Las Vegas, NV nias-uas.com FAA Part 107 Preparatory Course In-person training

Indiana State University

Terre Haute, IN indstate.edu FAA Part 107 Preparatory Course In–person training

Kansas State University, Polytechnic Campus

Salina, KS polytechnic.k-state.edu Test prep sUAS Commercial Pilot Training (Part 107) In-person training

Monroe Community College

Rochester, NY monroecc.edu Remote Pilot Ground School and FAA Test Prep In–person training

Northwest Michigan College, Traverse City Campus

Traverse City, MI nmc.edu Test prep Remote Pilot Ground School and FAA Test Prep Online training

UAV Ground School

Atlanta, GA uavgroundschool.com FAA Part 107 Preparatory Course Online training

there is a question where one answer seems to be better than the one you selected but you are not absolutely sure, go with your first choice; it has better odds of being correct. When you have finished double-checking your test, click the "Finish" button and get your test results.

Results

My study method worked well; I scored 92 percent correct and received my remote pilot's license. If you are self-disciplined, you can

pass this test by using study materials that are easily accessible online. If, however, you prefer to have a little help with your preparation, there are a number of fine schools that will guide you through it every step of the way. However you go about studying for the test, the Part 107 exam can be passed by anyone who takes time to learn the material, regardless of his or her prior knowledge on the subject. Good luck! ±



HOW TO

Model with CAD

WHAT YOU NEED TO KNOW TO DRAW DIGITAL PLANS

TEXT, ILLUSTRATIONS & PHOTOS BY GERRY YARRISH

omputer-aided design (CAD) continues to increase in popularity, and over the years we have received plenty of reader mail asking about what's involved in its use for designing RC models. Die-cut kits are all but extinct now, and many RC airplane kit manufacturers are now using CAD to produce construction plans and kit parts. Laser cutters, CNC routers and milling machines, and even high-pressure water cutters (for metal parts) start with CAD programs to produce their tool path files. Here are some of the basics for developing a set of model plans using a CAD program.

WHERE TO START

First of all, you can't just buy a CAD program and expect to start drawing plans overnight. Check out the various CAD programs available online, and pick one that matches your budget and computer requirements. There are many programs to choose from, and there are even some free downloadable CAD programs you can play with to get the hang of digital drawing. Once you've installed it on your PC, explore the features it has and get familiar with it to the point where you can draw basic shapes and line types. From there, you'll learn how to develop various geometric shapes. Most programs today come with detailed manuals and helpful tutorials for the basic functions of the program. If you really want to get into CAD, you can also go to a local technical high school or community college and enroll in a basic CAD class or two to speed your learning process. Another great place to check out the use of CAD programs is on YouTube, where companies like Ashlar-Vellum and AutoCAD have uploaded tutorial videos to help you learn their various programs and functions.

After you've mastered the basics, you can then start developing your own model airplane plans. For this, there are two directions you can take: You can design your own models and develop unique sport flier planes, or you can develop and enlarge scale 3-view drawings and reverse-engineer them into workable model plans.

BE A COPYCAT

Before you start using the CAD program, learn about basic airplane construction by first studying other people's plans. See how they laid their plans out and how they solved basic engineering and structural issues. This will help you understand the proper wood sizes to use for specific purposes. Also, notice the placement and spacing used between fuselage formers and wing ribs and other such structures. Refer to drafting and drawing books so that you can develop a good sense of how things should look when drawn in top, side, and front views. A working knowledge of drafting is a basic requirement for using CAD, so don't put your cart before the horse. Basic Drafting: A Manual for Beginning Drafters by Leland Scott (available from Amazon) is an excellent reference.

Next, find a good-quality, detailed 3-view drawing and scan it into a file that

can be imported into your CAD program. Try to find drawings that also have a few cross-sections and airfoils shown. With PC-based programs, this would be a bitmap (.bmp) format; for Mac users, a .pict file will do. You could use other formats, but these are the most popular. With the new Graphite platform, you can import several file formats, including text files (.txt), EPS, Metafiles, PNG, Claris CAD, .JPG, DWG (AutoCad), DXF, and IGES files. After your image is imported into your drawing file, you can begin tracing it with the various

These 3-view drawings were the basis of my plans. They are Wylam drawings that I cleaned up to eliminate unwanted details. 0 B AIR AGE INC., 551 FIFTH AVE., NEW YORK 17, N.Y SCALE: 4-1:0 Wing Rigging Wire Notes Detail A: Dual Flying Wires Detail B: Single Landing Wires CAME BUILT/9/7-18 BY SOPWITH AWATION COM

drawing tools your program makes available to you. And here is where many wannabe CAD users run into difficulty.

When I first started drawing plans, I began with simple airplane designs. Old WW I biplanes and home-builts have fewer curved lines and are relatively less complicated to draw than more modern aircraft. Start with the simple airplanes like the Curtiss Jenny, Fokker Eindecker, or Pietenpol Air Camper, then work up to curvier designs like Spitfires, Mustangs, and Warhawks. That being said,

here are some basic rules to get the most out of your CAD program:

USE LAYERS. Import your image and assign it to a specific layer. With my Graphite program, I assign the image to Layer 1 and I rename it "3-view." Place all the other drawing and details you add on their own separate layers. Think of layers as sheets of tracing paper laid on top of your imported 3-view. I typically trace the 3-view and then place structure (formers, ribs, and outlines

HOW TO MODEL WITH CAD

of other parts) on a separate layer named "Plan." Details such as the engine, servos, and other radio gear go on the "Hardware" layer, and so on. I even add my dimension lines, arrows, and information on their own layers. In this way, you can look at specific items by turning layers on or off, or you can look at everything all at once. This helps keeps things straight in your head.

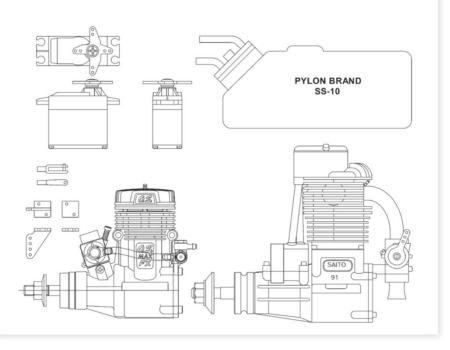
USE REFERENCES. Start all plans by drawing a datum line, centerline, or other reference line on the fuselage side and top views. From this, you can ensure that things like ribs and formers are drawn square with (or parallel to) one another. Vertical and horizontal reference lines also are important when you develop fuselage cross–sections and former shapes.

THINK SYMMETRICALLY. When it comes to things like wings and fuselages (in top view), draw only one half and then copy and paste a mirror image of it to complete the drawing. Do all your work on one side of the centerline, then duplicate it and flip it over to produce the other half. This ensures exact symmetry and cuts your drawing efforts in half!

SAVE DETAILS. One clear benefit of CAD is that you won't ever need to draw anything twice. Once you draw something like an engine, electric motor, servo, receiver, or control horn, save it to a master "Hardware" file. After you have saved them, you can then copy and paste them into new plan drawings. You can also enlarge, shrink, or modify them to make new master details. (Drawing them in top, front, and side views also is a good way to hone your overall drawing skills.)

TYPICAL RC HARDWARE

I think the best part of drawing with CAD is that it eliminates the need to draw anything twice. Once you've saved your files, you never have to draw those items again! Here are just a few RC hardware details I've drawn that I use over and over.



USE THE TOOLS. The Tool palettes included with all CAD programs are a collection of several useful drawing tools and functions. It is always easier to use these tools than trying to draw freehand over your imported 3-view drawing. Geometric drawing tools for circles, squares, ellipses, and arcs are all easy to use, and using them will make your drawings look cleaner

and more precise. Wingtips, engine cowls, and other parts are easily reproduced by combining segments of ellipses, curves, and straight lines.

WORK INWARD. After you've drawn your reference and centerlines, draw the outline of a wing half top view, fuselage side view, tail surface top views, and half of the fuselage top

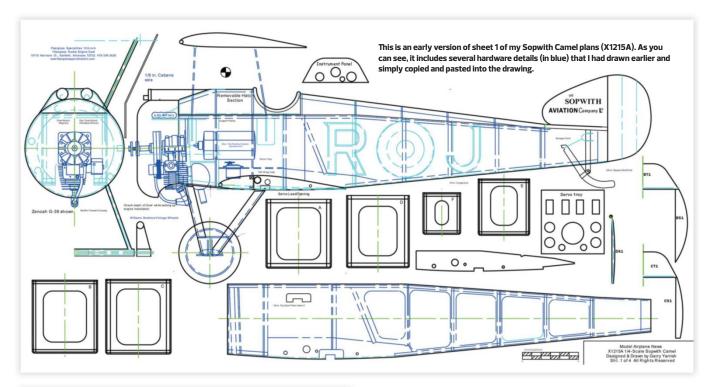
view. From here, you then establish the locations of the main formers, doublers, landing-gear mounts, wing spars, ribs, and so on.

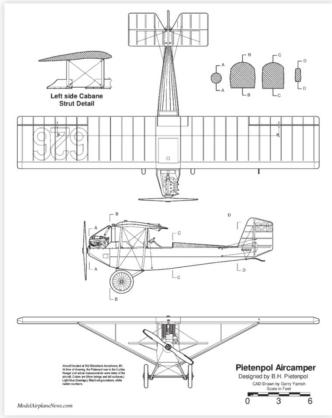
AIRFOILS. Investigate the many sources of downloadable airfoil plots, or consider getting an airfoil generator program. These will save you hours of tedious airfoil layout and lofting work. Above all else, remember this is a hobby, so using CAD should be—above all else—fun!

DRAW FULL SCALE. Once you have your 3-view traced and cleaned up, enlarge the drawing to the size airplane you want to build before you add any internal structures or details. This way, when you draw an 1/8-inch-thick



For some airplanes, like this Pietenpol Air Camper, you may not be able to find a good set of 3-views. This plane was based on one from years ago at the Old Rhinebeck Aerodrome. To produce my own 3-views, I measured the actual airplane and took a lot of photos.





This scale 3-view of the Pietenpol Air Camper was the very first CAD project I drew, in 1998. I enlarged these drawings to 1/3 scale (116-inch span) and then developed the plans I used to build the model.



Laser cutters are being used by many kit manufacturers as well as serious modelers to quickly produce parts from CAD drawing files.

RC LASER CUTTING SERVICES

One of the reasons that CAD programs have become so popular is that there are now several companies that provide laser-cutting services. You can scan a paper plan yourself and have parts cut for that design, but these plans, being hand-drawn by modelers, don't always produce accurate parts that fit properly together. Using CAD to produce airplane plans is the most accurate way to ensure that all the parts and pieces will match up. Here are just a few resources for getting laser-cut parts. Several of them work with well-known model designers and provide kits as well as laser-cutting services, with excellent results:

Lasercut USA lasercutusa.com

Laser Design Ser vices store.laser-design-services.com

Laser Lizard laserlizard.com

Manzano Laser Works manzanolaser.com

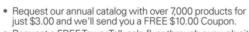
Top Notch Product Company topnotchkits.com

former or 3/32-inch ribs with $1/2 \times 1/4$ -inch spar notches, they will be the correct size. If you were to add all the details and then size the drawing for a specific wingspan, your details may not end up as common sizes.

BOTTOM LINE

Learning to use CAD for basic modeling is not all that difficult, and many experienced modelers have added this skill to their modeling résumés. For many, drawing plans with CAD can turn into another major part of the hobby. Before you know it, you'll have a whole collection of CAD 3-views and drawings to show your friends. The hard part will be picking which ones you want to build and fly! ±

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ME1010	GGT10 10cc Gas/Glow Ignition3 PAY 106.67	319.99
ME1011	GGT15 Gas/Glow Ignition3 PAY 126.67	379.99
ME1012	GT33 Gasoline	419.99



ME1019	DLE-20cc Gas	\$249.99
ME1020	DLE-30cc Gas Rear Carb w/EI & Muffler3 PAY 95.01	284.99
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CLARENCE F. LEE

MODEL ENGINE MAESTRO

TEXT & PHOTOS BY JOHN REID

When I first started in RC, glow power was king, and these magical engines powered every plane at the flying field. At that time, everyone had advice on how one should break in, run, and maintain a glow engine. While some of that advice was good and some bad, one person who everyone listened to was Clarence Lee, and since 1969, he has been giving that expert advice in his Engine Clinic column, first published in RC Modeler and now in Model Airplane News.

ENGINE BUILDER, TUNER, AND COMPETITOR

Clarence's history in RC model engines is a long one, and the first thing I found out about him occurred when I sat down to talk with him: This man can recall everything. He can remember names, places, times, and even the smallest details for just about anything that has to do with engines. I have been lucky enough to interview him twice, and it was like sitting in the room with a living, breathing history book on engines and their development.

As with all things, it is best to start at the beginning. Born in Los Angeles in 1923, Clarence grew up in Glendale, California. He built his first model at the age of seven and entered the world of powered aircraft at the age of 14. He worked for a year doing odd jobs so that he could buy an unassembled 1938 Bunch Mighty Midget. After graduating from high school in 1941, he started work at Vega Aircraft Corporation (a division of Lockheed Aircraft Company). Clarence entered the Army Air Corps as an aviation cadet trainee in December 1942.



Here is just a small example of some of the engines in Clarence's personal collection.

He had flight time on a number of aircraft, including a PT-19, AT-10, B-25, P-38, and P-51. Clarence was assigned to the China, Burma, and India theater, where he piloted C-47s and C-46s for the combat cargo group flying the "Hump"—the Himalayas from Burma to various airfields in China. In 1946, he was discharged from active duty and returned to the United States, but he remained in the Army Air Corps Reserve for 71/2 years. Once back on American soil, Clarence married his wife, Peggy. Pilots who had returned from the war a year earlier had filled all the commercial piloting jobs. So Clarence raised enough money, by cashing in some war bonds, to rent a building in Tujunga, California, and opened a floral business, where he and his wife worked for several years.

While in active service, Clarence started flying control-line models and continued until about 1956. After taking up remote control, Clarence was not happy with the power and performance of the current engines available for RC use. Because of this, he designed and

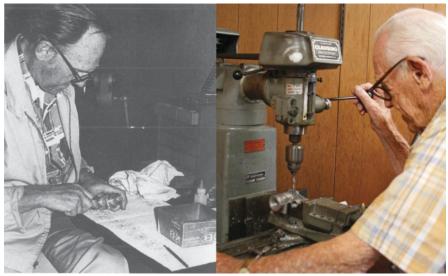


MODEL ENGINE MAESTRO

built his first Lee .45 engine just for RC planes in 1959. Clarence's custom–made Lee engines became an instant success and were used by many of the top pattern fliers at the time. Clarence sold the rights to Veco Products, and the engine became the Veco .45. After that, Clarence was commissioned by Veco to design a number of engines, including the Veco .19, .61, and .35.

Clarence regularly participated in pattern competitions for about 10 years but grew tired of the constant practicing required to be competitive. But Clarence found his calling when the new Formula I Pylon racing started. His first racing team was with his good friend Wayne Wainwright, and later he teamed up with his son. Jack Lee.

At 94, Clarence considers himself "semi-retired," but he has never been one to take it easy. Having sold many thousands of custom-fit versions of K&B engines over the years, Clarence has serviced and repaired these engines as almost a full-time endeavor for some time now. He admits, however, that the emergence of electric motors has somewhat slowed down the maintenance work for glow engines (although while I was there for this interview, there were a number of repaired engines sitting on the bench ready for shipment). This is perhaps the closest Clarence



During the day, you can find Clarence working in the shop on machines that have been around for as long as he has

has been to semi-retirement, but writing his Engine Clinic column every other month while still working on engines out in his shop during the week seems like working to me. Of course, Clarence disagrees with that; he says he is having too much fun to stop. One can say that true retirement may never be in the cards for

Clarence. And all of us that depend on him to solve our engine problems, which is just about everyone I know, are very glad he is still out there sharing his knowledge with us. We thank him for that. ±







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The Bee Liner

A multimotor plane from the father of the Lazy Bee

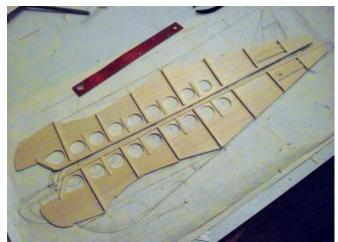
suppose you might be expecting something "lazy." Let me introduce you to the Bee Liner, a plane whose finest trick is just sitting "stationary," taking a break, reclining in the air. You can do this stunt pretty easily. The Bee Liner stays airborne because it has four propellers blowing air over its wing. Be sure to read the complete instructions (at ModelAirplaneNews.com/beeliner) before you make the parts. Don't make the fuselage sides until you have read that section. Most of the parts should be made out of good hard balsa. There are few parts, and they are simple.

THE WING

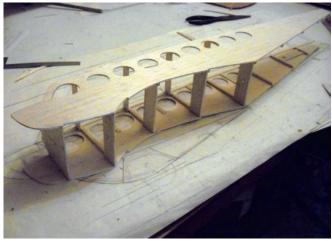
Build each of the three wing panels separately, from front to back. The best way to make the leading edge just as straight as it can be is by lamination, which is actually pretty easy. The ailerons are built as integral parts of the tip panels and will be cut away later, after the completed wing has been sanded to shape.

NACELLES

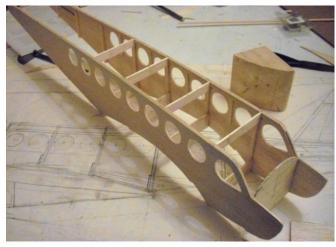
Each nacelle is built like a small fuselage. The outer pair houses the aileron servos. Use the wing as a building jig to make sure the outer nacelles match up to the wing. A tricky part: When



The fuselage starts by assembling the two fuselage sides. Make a left and a right side.



Using the crosspieces, join the two sides so that the sides are properly aligned.



Here, you see that the fuselage sides are parallel to each other and easy to frame up.

your four nacelles are all made, you will need to drill two holes in the firewall of each one for the wing dowels to plug into. These holes will need to be precisely located. The engine nacelles are designed to allow for different-size motors to be used. The nacelles are intended to look good with either uncowled motors or cowled-in motors.

FUSELAGE

The fuselage is a simple box structure that has a keel on the top. It is designed to be assembled upside down over the top view of the plans. The peaked roof is built later. The three tail surfaces are mounted and aligned by carbonfiber rod spars. The tail surfaces are secured by rubber bands. The wing fillets are built up

on the bottom sheeting. Carve the nose block from a single piece of soft balsa. It's difficult to smoothly shape glued-together soft balsa; if you can't find a big enough block, use medium balsa. Use a Dremel Moto-Tool to hollow it out from its back side. Do the final sanding and shaping after gluing it in place.

Now the top of the fuselage can be built up.



The bottom sheeting forms the base of the wing fillets.



Sand and shape the nose block before you install the windshield frames. The bottom edges will need some beveling to fit. Lightweight spackling fills the gaps.





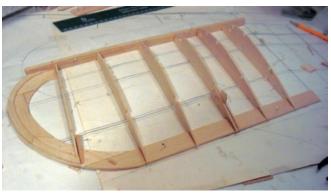
CONSTRUCTION THE BEE LINER



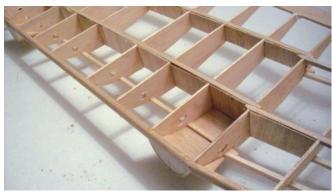
Note the access holes for the wing hold-down dowels. This is an effective and streamlined way to attach the wing to the fuselage using rubber bands.



The wing center section takes shape.



Here, one of the two outer wing panels is being assembled.



The dihedral is made with simple lap joints.



The dihedral is set with a jig piece under the wingtip.



Here are the parts for a nacelle assembly.



The nacelles go together like little fuselage assemblies.



The motor cowls are carved and sanded in place on the nacelles, then you hollow them out. They are a lot of work, and the plane does still look good without them. The online article shows some easier cool-looking alternatives.



Here are two nacelles: The bigger one is the inboard nacelle, while the smaller one is the outboard one, which also will contain the aileron servo.



The horizontal tail will be shape-sanded, then the two surfaces are separated. The front of the elevator should be round. The airfoil will be mounted inverted.



Note that the horizontal stabilizer is attached to the fuselage with the flat side up.

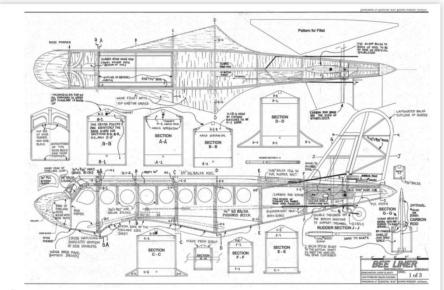
Install all the triangular top formers; they are the pieces that give the fuselage its peaked-roof shape. The keel goes in after these (fitted dry) and then the windshield frames. The battery hatch is built up in place using the fuselage as a jig. Do not remove the hatch until later, after the finishing shaping and sanding is done. I used small magnets to hold the hatch in place. The sides of the keel have to be built up with scrap balsa to form a base for the vertical

After you glue in the wing-alignment dowels and the pieces that form the underside of the wing fillets, install the remaining bottom sheeting. On the last piece of sheeting, you'll need to glue on a pair of sticks to form a slot. This is to hold the end of the rudder spar securely so that the vertical tail doesn't lean from side to side.

THE TAIL SURFACES

Use medium/light balsa. The vertical stabilizer has a symmetrical airfoil at its base and a flat airfoil at its tip. It has a center core frame made out of 1/4-inch-square balsa sticks. The outer sticks will need some carving to form the airfoil. Then you need to drill the holes for the spar.

The rudder and the horizontal tail have



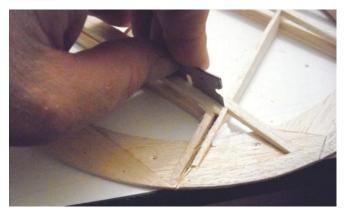
Bee Liner | X1117A

Designed by Andy Clancy, the Bee Liner is the latest in the Lazy Bee series. It is meant to be particularly versatile: docile yet capable of providing challenging stunt flying to an expert pilot. The model uses simple built-up wood construction. WS: 51 in.; L: 32 in.; radio: 4-channel; power: (4) small brushless motors; LD: 2; 3 sheets; \$16.95.

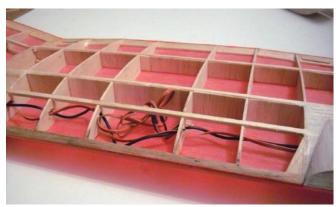


To order the full-size plan, visit AirAgeStore.com.





Here, I am separating the aileron from the wing structure before covering it.



Notice the vertical grain webbing applied to the wing spars and the holes in the ribs for the wiring to pass through. Don't forget about installing pull strings before you cover it.



Here, the fin and rudder are in place on the tail of the fuse lage. $\label{eq:continuous}$

laminated parts, so start with those. The rudder is a simple frame that is built in place over the plans and attached to the vertical tail with hinges. I favor removable hingepins to facilitate quick repairs as rudders tend to be a hot spot for damage. The horizontal tail uses a flat-bottomed airfoil turned upside down. So it's a flat-topped airfoil. Build it upside down, starting with the two tapered spars. You will build the horizontal stabilizer and elevator as a left-side pair and a right-side pair. Each pair is built in one piece and will be separated into a stabilizer and an elevator only after the shaping/sanding has been done.

The horizontal stabilizers can be glued to the fuselage, or they can be rubber-band-mounted. A small hook can be attached to each horizontal stabilizer's root rib. Holes in the fuselage sides would allow a rubber band to pass from the hook on one side, through the fuselage, to the hook on the other side.

COVERING AND BALANCE

This plane has a lot of surface area, and it will need two rolls of covering.



Caution: Really Big Lazy Bee Ahead!

by Budd Davisson

Editor's note: Budd is the editor-in-chief of our sibling publication Flight Journal, a magazine dedicated to full-size aircraft and heavy metal World War II warbirds. Budd also has a soft spot for RC models.



Everyone needs a crazy idea to fuel their day-dreams. All right, folks. I'm about to give everyone a license to laugh at me. (I expect this; actually, I encourage it because it's not healthy to keep a good belly laugh bottled up.) Many folks have projects lounging around in the back of their minds that they'd like to do. Most are super low priority and many aren't even close enough to a back burner to stay warm. Usually, they are forgotten for long periods of time. Then something triggers an interest button, and they slide over onto a burner, come to a slow boil, then drift away to cool off again.

I have literally hundreds of folders lying around that cover all the back burner ideas I've ever had. They act as repositories for notes, thoughts, articles, and drawings for each project, and the "Lazy Bee File" had all of those. At one point, I had done a lot of thinking about it. What, you may ask, is a Lazy Bee? An insect on welfare? No. It's a model airplane, designed by fellow Zonie, Andy Clancy, that has totally captured the imagination of the modeling community to the point that it's gone past fad status to become a full-blown legend. This is pretty amazing considering it's as funky as dirt. Maybe funkier.

It should be noted that the Lazy Bee's so-uglyit's-cute looks wouldn't be enough to make it a runway pop star unless it was also an incredible flier. It started out as a super-light backyard flier with something like a 2-foot wingspan and has now been cloned in every size up to 17 feet!

The instant I saw the airplane, my brain went

into hyperdrive, and the corner of my mind that's always reserved for designing airplanes began frantically dusting off mental drawing boards and polishing the rust off old engineering neurons. A message flashed upon my mental annunciator panel: I want to build a real, human-carrying version of this airplane!

In a matter of seconds, I was imagining truss layouts for the tubing fuselage and ways to make the round window frames. Images of possible wing fittings to handle the outboard joint popped into my mind like flip cards until I had to sit down with a sketch pad so that I wouldn't forget what my mental eye was seeing. Landing-gear designs rattled on stage, were examined, and then discarded. Everything from wheel-to-wheel leaf springs to an outrigger gear with a vertical shock strut pinned to the top of the fuselage (now that would be classic) made a showing. My brain was on a roll. Somehow, however, as life took its many turns, the Bee trundled off to mental obscurity and was forgotten-until yesterday. Now I'm in the Bee game again and ready to rock and roll.

Yeah, I know. This is a really crazy idea, but picture looking up on final and seeing those big balloon tires, slab-sided fuselage with windows shaped like John Denver specs, and polyhedral wings coming at you. What an absolute hoot! Will I do it? Maybe. Besides, I have a Pitts and I manufacture four-place, 260hp airplanes, so it's only fitting that I have an airplane that redefines the word "funky."

While not a humancarrying version, this giant-scale KirBee is about as close as you can get. Kirby McKinney's 17-footspan Lazy Bee was built in a team effort with Mark Davidson. and like the original Lazy Bee, it has only throttle rudder and elevator control. And it flies great! First flown in 2009, it was powered by an Air Hobbies 9.8ci twin-cylinder engine. It weighs 80 pounds and is now hanging in the main hangar at the Triple Tree Aerodrome in Woodruff, South Carolina. (Photo courtesy of Laura McKinney)

The weight of that covering will make a giant difference in your plane's performance. So keep it light! Balance the model about 1/2 inch behind the main spar. This will make it somewhat nose-heavy and docile on the controls. The battery is mounted on the center of balance and can be shifted forward or aft to alter flight performance.

FINAL ASSEMBLY

Because of its frame, the Bee Liner is not fussy about the motors or the size and weight of the radio equipment. But I always favor the lightest–weight equipment. If it will fit and there is enough power, it will fly. Keep in mind that your props need to be 7.5 inches or smaller. (Gear–driven motors raise the thrust line and can use larger props.) For the best all–around flying, I'd choose four small outrunners that

are intended to fly a 3D plane of about 6 to 10 ounces.

To test the upper limit, I used the Electri-Fly RimFire 400 brushless outrunners (GPMG4560) with 7x4 props (smaller than these motors normally use). This was the maximum power the plane could handle (it would have been overpowered with only two of these motors!). The heaviest battery was a 3-cell 3350mAh pack. For baseline simplicity, I think something like the Grand Wing Servo GWS 300H C direct-drive can motors with their 5030 propellers and a 2-cell LiPo pack would be about the least expensive thing that would fly it.

Although I didn't use them, counterrotating propellers could be an improvement. There would be no torque constantly trying to turn the plane. I'd arrange them so that the prop

tips move outward above the wing; that way, if any motor fails, the uneven asymmetric thrust would be minimized.

BOTTOM LINE

Flying this plane is fun and exciting. It's a Bee, after all! The Lazy Bee series of planes was meant to be particularly versatile: docile yet capable of providing challenging stunt flying to an expert pilot. The Bee Liner is no exception. Stalls are predictable and gentle. The response to stick and throttle is quick and powerful. If you take your hands off the controls, the Bee Liner will quickly go to straight and level from any nightmare attitude. It can be maneuvered in very tight spaces. Flying at its slowest speed, however, does take a little experimenting with technique. ‡



HOW TO

Solder Deans Ultra Connectors

AN EASIER WAY TO MAKE SOUND JOINTS TEXT 6 PHOTOS BY JERRY SMITH

enerally speaking, most newcomers to our hobby don't really know how to solder. This isn't that surprising because most of today's electric-power systems come plug-and-play, and soldering isn't as required as it once was. There are, however, some occasions when soldering is needed, as when you're dealing with new battery packs that don't come with the connectors installed.

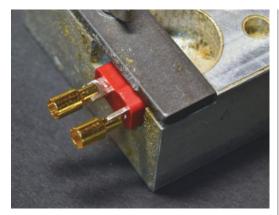
Soldering is the fastest and most reliable way to join metal, and a soldered wire joint is both mechanically stable and electrically efficient. Available in different diameters, the standard solder we use for electrical RC wiring is 60/40 rosin core solder. It consists of 60 percent tin and 40 percent lead, with the rosin inside the hollow body of the solder. Koster solder is the most popular, but most building and home–improvement stores carry other brands. The important thing is to use the proper 60/40 type.

Solder is not capable of taking a lot of stress or movement, so it is a good

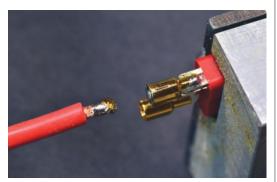
idea to use shrink tubing over the joint to help support the joint and to insulate it from short circuits. I ran into a problem soldering large–gauge stranded wire to the lugs on a Deans Ultra Connector. The lugs are close together, and I just wasn't satisfied with the outcome. There was little mechanical connection between the wire and connector's lug. Instead of trying to tin and solder the ends of the wires to the lugs, I found a better solution: using the EZ Soldering Coupler for the Deans Ultra Connector, available from Maxx Products.



Here are the Deans Ultra Connectors and the EZ Soldering Couplers. The couplers are made to fit the lugs on the Deans connectors. They are a snug fit but will slip into place without having to spread the coupler open—don't try, as you can break them.



Place the connector into a holder, then place the gold-plated couplers on the connector lugs. I like these heavy metal clamp holders as they are steady and do not move around when you are making solder joints.



Tin the ends of the wire. I have found that a holding fixture, like the Handy Helper (available from Home Depot), makes soldering wires easy. It holds the wire firmly and allows you to apply the heat from under the end of the wire and the rosin core solder from the top. When the wire is hot enough, the solder will flow easily into the wire strands. Then, do the same thing to the couplers and the lugs: Apply heat from under the joint, and apply the solder from above. When the parts are hot enough, the solder will flow into the joint. You can see here that I also tinned the inside of the coupler, where the end of the wire will be inserted.



To attach the wire to the coupler, heat the coupler with the soldering pen while inserting the end of the wire. When the coupler and solder are hot enough, the wire will slip into place and the solder will flow to form a perfect joint. Here, you see the complete solder joint joining the wire to the coupler and the coupler to the connector's lug.

SEVEN SOLDERING SECRETS

→ The secret to making good solder joints is to use a sufficient amount of heat. If you don't use enough heat, your solder joints will appear rough and dull.

- → Proper solder joints are flowing and bright.
- When applying heat, do not apply solder directly to the tip. Add a small amount of solder on the tip of your iron and then touch it to the pieces being soldered. The solder will help carry the heat from the iron to the joint.
- → Heat the base metal so that it becomes sufficiently hot to melt the solder, then flow more solder into the joint from the opposite side of the part. Once the solder has been applied to the connection, remove the soldering iron and let the joint cool without disturbing it, until all the solder has solidified and cooled.
- → Avoid using too much heat, and don't apply more solder than needed.
- → Always pre-tin components before soldering, especially stranded wire.
- → Keep your soldering iron clean, and have a damp sponge handy to wipe off the tip oxidation. A clean iron promotes good heat transfer.



It is important to slip a length of heat-shrink tubing over the wire before your make the solder joint. Slide the tubing away from the end of the wire while soldering so that the heat does not cause it to shrink and make it difficult to slip over the joint.



Once the solder joint has cooled, slide the heat–shrink tubing over the solder joint so that it completely covers the lug. Use a heat gun or a hair dryer to shrink the protective tubing into place.



As an added bit of protection and strength, I slip a larger length of tubing over the connector and the wire leads, then shrink that into place. This takes the strain off the solder joints, so the battery connectors will last a long time.

Once you know the basics of soldering, you'll find that it really isn't all that hard. But to make battery connections even easier, use the EZ Couplers to make the process quicker, stronger, safer, and longer–lasting. \pm

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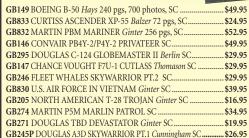
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TEXT & PHOTOS BY **JOHN KAUK**

ABCs of connectors

ASSEMBLE YOUR CONNECTORS WELL WITH GOOD SOLDERING FOR LOW RESISTANCE



Modern connectors come in two basic types: those with flat blade-style contacts and those with round pin-and-socket contacts, known as bullet connectors. Both styles have advantages and disadvantages, and making a choice can be difficult.

BULLET CONNECTORS

There are quite a few types of bullet connectors available today. In their simplest form, they're used plain and almost bare, with the pin, or male, part of the housing completely uncovered so that it can plug into the socket, or female part. The socket and the base of the pin should be covered by heat–shrink tubing so that the connected pair is fully insulated. With care they can be used safely, but there is no standard orientation for them, and that can lead to problems. I have shorted plain bullet connectors before and seen others do it, and it's no fun.

A solution for some of the shortcomings of the plain bullet connector is to develop a housing that protects the connectors from coming into unwanted contact, insulates them both in use and storage, polarizes them so that it's not possible to plug them together in the wrong orientation, and helps the user grip them for connecting and disconnecting. Not surprisingly, there have been several different designs brought to market, so the electric–power flier has a wide range of choices.

EC CONNECTORS

Horizon Hobby uses blue EC3 and EC5 connectors, which are bullet connectors snapped into a polarized housing. The EC3 uses a 3.5mm connector and is rated at 60 amps. The EC5 has 5mm bullet connectors and is rated at 120A. Both connectors share the same basic shape and are assembled similarly. The wires and connectors are soldered



The 4mm bullet connector on the left has a spring-type contact, while the Castle Creations 6.5mm bullet connector is a solid design. The larger, more massive connector has lower contact resistance and carries more current.



The EC5 connector is a polarized housing for 5mm bullet connectors used by Horizon and E-flite, among others.

together and then the connectors snap securely into the housings. They're impossible to connect incorrectly, are easy to grip and use, and provide good protection from electrical shorts.

XT CONNECTORS

XT connectors are bullet connectors that are molded into a uniquely shaped yellow nylon housing. XT60s have 3.5mm bullet connectors with a rating of 60A, while XT90s have a 5mm bullet and 90A rating. Since the connectors are molded into the housing when manufactured, wire is soldered to them in place and covered with heat-shrink tubing



The XT60 plug is fast becoming the standard for multirotors and racing quads. Some charger manufacturers are using them in place of the commonly used banana jacks and plugs.

to insulate the bases of the connectors. Some XT connectors have a molded cover that snaps to the base of the plug and provides insulation for the wires. They're easy to assemble, are well polarized to prevent connection mistakes, and have good gripping surfaces.



The Optipower Ultra Guard 430 is small, only weighing about 40 grams. It's simple to install and easy to maintain, as it charges itself from the primary power supply.

OPTIPOWER ULTRA GUARD 430

One of the things we learn as RC fliers is that eventually everything fails. I checked a 2S A123 receiver battery just before a flight recently and found that it had done just that. As I packed up and headed home, I decided I was pretty lucky that it hadn't failed in flight and cost me a plane. But the more I thought about it, the more I wondered if there was a good way to safeguard against that happening to me. As it turns out, there is.

Optipower's Ultra Guard 430 is a battery-powered smart backup system for RC receivers. Its purpose is to give a pilot enough power to land a model in case of a failure in the primary power supply, whether that's a battery or a BEC (battery eliminator circuit). One of the biggest advantages it has over other similar products is that it charges and maintains the 2S 430mAh LiPo battery as you fly on the main power source, so it's not yet another battery to monitor and maintain. If the main source voltage drops more than a half-volt, the Ultra Guard takes over and flashes a bright LED to let you know. There's an extension LED so that you can mount it in a more visible location.

Small and light, the Ultra Guard senses voltage from 2 to 8.2 volts and is rated to provide 5 amps continuously and 10A intermittently. It plugs into the receiver via a universal connector and uses the JST-XH balance tap from the LiPo to power the main board and LED. Available from optipowerbattery.com, the Super Combo includes the Ultra Guard and additional LED for about \$55.00.

POLARIZED CASTLE CONNECTORS

Castle Creations has a green plastic connector housing offered in a couple of sizes. The smaller one uses 4mm bullet connectors and is rated at 75A. The large size carries 6.5mm bullets and has a 200A rating. Both sizes are polarized, are easy to grip, offer great protection, and use Castle's solid pin contact design instead of a spring design. To assemble them, the wires are passed through the housing and soldered into the cups on the base of the connectors. Then the connectors snap securely into the housings. Castle also sells bare bullet connectors in 4mm, 5.5mm, 6.5mm, and 8mm sizes, which are well suited for connections between the speed control and motor.



The original red Deans Ultra connector and an improved version of the Star Plug. The Star Plug has grips molded into the plastic and a segmented cover for the solder connections that helps prevent wire contact.

FLAT BLADE CONNECTORS

A second type of contact utilizes flat connectors. Electrical connection is made by two blades of conductive metal sliding together that are held in tight contact by a spring in the housing. Like bullet connectors, these connectors have good connection properties when properly assembled.

ULTIMATE ELECTRICS

T-PLUG CONNECTORS

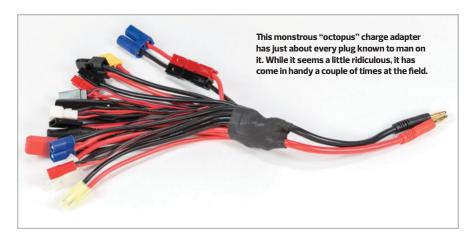
These connectors get their name because the orientation of the blades in the molded body resembles the letter "T." The Deans Ultra plug was the first of this style and has been in wide use in electric-power equipment since the late 1990s. The company doesn't publish a current rating, but many people who use them consider 50 or 60 amps to be a good limit. To assemble a T-plug, the wires are laid on the flat blade and soldered to it, then covered with heat-shrink tubing for insulation. Some people who use them have trouble disconnecting them, and they can be fiddly to solder properly. They are polarized, so plugging them together incorrectly is very hard to do.

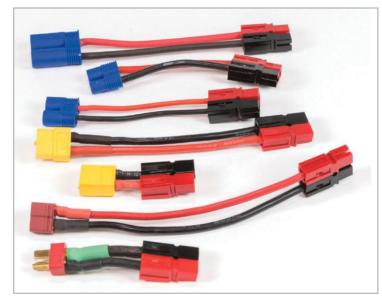
Hobbico's Star Plug is an improved variant of the T-plug, with a nicely shaped housing that has grips molded in. There's a rear cap with a center isolator that snaps securely onto the housing to separate and insulate the wires, and it provides additional gripping area for easier disconnection.

ANDERSON POWERPOLES

Anderson Powerpole connectors are flat-bladed pin connectors that have cups formed into the rear for wire insertion. They can be soldered or crimped, and the pin snaps into a plastic housing that can key into other housings to make polarized plugs in several variations. Powerpoles come in 15-, 30-, and 45-amp pins that all fit into the same housing. Used singly they're not polarized at all, and are easy to connect improperly, causing dangerous shorts. I know; I've done it myself several times.

That said, I've used Powerpoles for going on 30 years. I bought a crimper from West Mountain Radio that makes them fast and easy to assemble, with a better connection than soldering. Since I've started always keying the individual housings together to make polarized plugs, they're perfectly safe, even for me. I've found them to be conservatively rated by Anderson, and I use the 45-amp connector regularly in power systems that exceed 75 amps with no heat buildup or other problems.





Some of the author's home-made adapter collection. Some are for charger connections and some are for flying, using batteries with different connectors.

ADAPTERS

"Hey, I left my charger at home. Can I use yours?" "Do you have a 3-cell battery I can use for a flight?" I can't tell you how many times I've been asked these questions, and with all the different types of plugs used by different vendors, it's often hard to say "yes" because my connectors aren't compatible with theirs. Adapters are the solution.

Adapters are simply one type of connector

(the one that you use the most) connected to another type. They can be at either end of lengths of wire, or soldered directly together if possible. After a while, a modeler can end up with quite the collection of adapters.

BOTTOM LINE

One of the nice things about being an electricpower flier today is the wide variety of choices we have in connectors as well as in other gear. That wasn't the case when I was starting out. I've standardized on Anderson Powerpoles for battery and charger connections, and plain bullets for speed-control-to-motor connections since they don't get disconnected often. If I were just getting into electric power today, I'd use one of the bullet connector housings as they're all good choices. All the types discussed here have good contact resistance for reasonably low losses if used within their ratings. Regardless of which connector you choose, it's important to learn how to assemble them well, with good soldering for low-resistance connections. **‡**



These battery adapters convert from XT60 to T-plugs, EC3s, and Anderson Powerpoles. The red and blue adapters are from Venom Power.



Product Watch

MINI REVIEWS OF FDITORS' FAVORITES



With its universal three–jaw chuck, the Dremel 4300 doesn't require additional hand tools to change tool bits, so it's compatible with all Dremel attachments and accessories. It also features an all–new swivel light, which provides illumination for tight and hard–to–reach areas where you might work. The Standard Edition includes five attachments and a great selection of 40 Dremel accessories, with a molded storage case that holds the tool, all the attachments, and accessories. The 4300 is also available in a Platinum Edition, which includes eight attachments as well as the Flex Shaft attachment and 64 Dremel accessories. Its large storage case is equipped with metal latches, reinforced corners, and a foam–lined drawer.

The Standard 4300 tool includes a variety of useful grinding bits, sanding drums, polishing pads, and EZ Lock cutting discs, all of which are ideal for most RC modeling tasks. A noticeable feature of the 4300 is a built-in variable speed and electronic feedback circuit that helps keep the motor running at peak performance. When you switch on the tool, you can feel the torque ramp up, which minimizes stress on the bearings and brushes. The adjustable speed dial and separate on/off switch make using the tool for various jobs highly intuitive. It is easy to dial in the exact rpm you need for a given task.

I've been using Dremel products for decades, and the 4300 is the best yet. I highly recommend this new rotary tool for any model-building task. The Dremel 4300 is available online and at select retail locations for \$119.99 (Standard Edition) and \$199.99 (Platinum Edition).—*Gerry Yarrish*

dremel.com



Fliteskin Fiberglass Sheeting When it comes to covering and finishing scale model airplanes, a big part of the

When it comes to covering and finishing scale model airplanes, a big part of the process is producing a smooth, blemish–free surface for the base of your paint scheme. For World War II fighters and other sheeted airplanes, you do this by applying fiberglass cloth and resin, then filling, priming, and sanding until you produce a smooth finish. But there is also another, much easier way—especially when you are duplicating sheet—metal surfaces on fabric–covered airplanes.

Fliteskin is a fiberglass sheet material with a built-in smooth finish. For many professional modelers and competitors, Fliteskin has become the standard for airplane covering whenever a realistic scale finishing is required because it saves





countless hours of sanding and priming work. I decided to use 0.010-inch Fliteskin when I was covering and finishing my Balsa USA Fokker Triplane, as I found it to be the closest representation of the real sheet-metal finish on the full-size aircraft. I have tried sheet aluminum and thin metal flashing, but these did not work as well and were heavier than Fliteskin. Plus, Fliteskin is translucent, so you can see through it and mark it exactly as you need it for cutting to size. Once cut to the shape you want, just screw it in place (along with some glue on the underside) and it's ready for priming, depending on the paint you are using.

The material is flexible, easily going around curved surfaces, and it is very strong for ding resistance. The unpainted material is fuel– and weatherproof and can be primed and painted without any surface prep. I did clean the surface with some denatured alcohol before painting, but no scuffing or sanding was required. Fliteskin is available in 36 x 48–inch and 36 x 24–inch sheets in 0.007 and 0.010 thicknesses.

Fliteskin can also be used to line cockpit interiors, wheel wells, and channels in wings, and can be glued directly to built-up and foam wing and tail surface structures in place of wood sheeting. This saves both time and weight, and also allows you to form very thin yet strong trailing edges that won't chip or dent. Because you can see through the skin, you can precisely cut it out when placing it over plans, ribs, and formers. Priced from \$25.50 to \$48.50 depending on size and thickness, Fliteskin has a lot to offer the scale modeler.—Gerry Yarrish fliteskin.com

FINAL APPROACH



wanted a warbird that isn't seen too much at the field, and the Martin B–26 Marauder medium bomber fit the bill. It's the same class as the B–25 but just isn't modeled as much. I wanted as big a model as I could easily manage, and with a wingspan of 142 inches, 1/6 scale seemed doable. The B–26 is a scratch-build from three views (and whatever information I could find in books and on the Internet), right down to the landing gear and wheels. The construction materials are less

common and include foam, light ply, and carbon fiber, and the structure is completely fiberglassed. I tend to design and build on the fly.

My B–26 has flaps, retracts, and functional bomb–bay doors, which operate like those on the full–size bomber. Most of my models are electric and I've taken some flak over the years for them being too quiet, so I knew this B–26 would need to have the right sound. I wanted to do a twin engine but didn't want to live through losing an engine and the heartache that might go with it, so building gas/electric hybrid engines came to mind. I picked up a Zenoah G38 at a swap meet and connected its rear shaft to a 3000–watt, 200Kv motor I already had. I knew from other builds that the electric alone would turn a 24x12 prop about 5200rpm, and with the G38 trying to get to maybe 7000rpm, the result would be somewhere in between. The hybrid setup produced a scary amount of power and sounded great when I demonstrated it out at our field on a sawhorse (firmly nailed to the ground!).

So far I've got six flights in on my scratch-built 1/6-scale B-26. I was hoping to keep the model less than 50 pounds, but in the end, it did not happen. At 64 pounds, it's now signed off with a Large Model Aircraft waiver and has nine great flights as of this writing. I'm still working on the final scale details, including the invasion stripes and nose art, and I look forward to sharing more details in a longer article in *Model Airplane News*.

THE B-26 AT THE WOODLAND DAVIS WARBIRD FLY-IN.

I've been asked many times, "Why hybrid engines?," and half a dozen reasons came to mind. First is the reliability: If the G38s die for almost any reason, the electrics will keep them and the props spinning, albeit at a reduced rpm. Also, the 4hp electrics can easily spin the G38s so that they can be started right from the transmitter. Besides the convenience, it's much safer without needing to get near or in front of the props. In addition, because the props get spun up to about 4000rpm, no chokes are needed. One goal was the right sound, and with custom exhaust manifolds, no mufflers, and 16-inch dual exhaust pipes on each engine, it comes close to sounding like a real bomber. The last benefit I'll mention here is that

the G38s fit entirely inside the nacelles, but they might have trouble getting the plane off the ground by itself. Together, each hybrid will approach 7hp, for a total of 14hp. When I testbenched the hybrid, I included a boost converter similar to one implemented in an automobile to allow the gas engine to charge the batteries. This worked fine but would not be too useful in this application as the G38s alone would have to be working hard to keep the B-26 in the air without charging batteries at the same time.

I like to build from scratch and have found that three-view drawings and pictures available on the Internet are enough to build from without actual plans. Bulkheads and ribs can be blown up to the desired scale, printed out, and taped to the material of choice (foam sheeting, in this case) for cutting. I generated the print scaling numbers in Excel, taking into account the thickness of the quarter-inch underlayment foam I've been using. Structural critical parts were either sheeted with fiberglass of appropriate thickness or cut from plywood. The spars are capped with carbon fiber.

The engine mounts are thick-walled S-glass tubing with engines bolted to plywood bulkheads. The two motor shafts are connected by automotive hose, heavily compressed with a steel clamshell. To minimize vibration, alignment is critical. I use the Castle Phoenix 100-amp controllers and 8-cell 5000mAh batteries on each engine. Tuning was achieved by programming unique throttle curves for each of the four motors, matching rpms, electric currents, and head temperatures at all throttle positions. I'm not working the G38s too hard yet, enabling only about 60% throttle to keep their temperatures down. I will eventually increase their load as their temperatures are getting to only about 220°F in the air versus 310°F statically on the ground. Flight times will go up from 10 to 15 minutes as I use more of the 24-oz. fuel tanks and less battery.

THE COMPLETED HYBRID ENGINE

The landing gear and tires are all scratch-built from foam, S-glass, carbon fiber, and aluminum. I vacuum-formed the nose cone, canopy, top turret, and tail section from 40-mil PETG plastic. I am using my 14-channel Futaba for the flight controls and a Taranis Telemetry system to collect performance data.

You can see more detail on the build at rcscalebuilder.com, where you will need to register as a guest. It was more than a year into the project when I found this painting of serial number 296165. It's flying season now, so it will be a while before I finish the painting the model.

Keep 'em flying. +





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